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THE PRESSURE OF POPULATION

THE word 'science' normally connotes physical and chemical science to the public mind and the lay press, to whom biological science is part of medicine, and it is not realized that there is also a science of world affairs and economic problems. Yet if the problems of peace, already beginning to be agitated, are not this time solved largely in a scientific manner instead of being left to politicians and international financiers, the result will be no better than the unsuccessful attempt at a new world which came into being after the ill-fated Treaty of Versailles.

Most of the immediate problems arise as the result of pressure of population, a phrase which is sufficiently elastic to extend to many problems, all of them capable of scientific analysis. One column of the daily newspaper informs us of the number of unemployed in Great Britain or in the United States, whilst in another there are statements in regard to the inevitable consequences of the fall in the birth-rate. The average citizen cannot make up his mind whether there are too many or too few people in England. He is at least aware of the economic conditions which make him unable to afford a larger family himself if he has to feed and clothe and educate them ; he also knows that the absence of domestic help is another factor against the larger family. He cannot understand either, why there should not be ample work and a livelihood for a larger population in Canada, where there has been so much unemployment. In the end, he asks the question, whether there are too many people or insufficient capital ?

This is a question which merits the attention of the man of science. There are many methods of approach to its study, one of which is the historical. Something may be learned by a comparison of the state of development in England at the end of the eighteenth century and that existing to-day in the Balkan countries.

There was then a population surplus in England ; indeed it was in 1798 that Malthus published his famous essay and predicted a sorry fate for mankind, which he pictured as growing faster than the food supply. Sir William Crookes was equally concerned about the food situation in his now famous address to the British Association at Bristol, only a year or two before the chemists learned how to make nitrates from the air and so put an end to any fear of food shortage. To-day the world can produce such an excess of the staple foods that their value, as the result of competition, shows no profit to the grower over the cost of production.

Statistics indicate a population of about 60 inhabitants per square kilometre for England and Wales in 1800, whereas, according to Prof. Ernst Wagemann, who has recently published (in German) a most exhaustive study of this question, that of the Balkan Peninsula to-day is about 62 ("Der Neue Balkan", Hamburg, 1939).

In 1800 conditions were very bad in England. Bad harvests, the ill effects of war, financial and trade disturbances brought the country near to famine and the brink of ruin. Large land holdings and pasturing were spreading and exerting pressure on the peasantry. There existed an ever-increasing agricultural population surplus which had to be cared for by somebody. In the Balkans this surplus exists to-day. The relative figures are significant. Only 63 per cent of the actual labour supply is being used ; in Bulgaria at least 750,000 men could be withdrawn from agriculture

without injuring production. Some 114 persons are employed per 100 hectares of cultivated land against 50 in France and Germany, 17 in the United States. Life is said to be quite comfortable for the peasants who own their own farms.

The population density figure of 60 is small compared with highly industrialized countries; in Belgium it is more than 200, and it is clear that the Balkans are over-populated only in relation to their economic and technical development. As Wagemann puts it, they are "under-technicalized" rather than "under-capitalized".

It is desirable to stress the implication to Britain and British industry of this conception of countries with "too many people". It has long been the policy of Great Britain to expect the world, and her Dominions and colonies in particular, to produce foodstuffs and raw or quasi-manufactured materials, and to leave to Britain the elaboration of these in her technical industries. There are to-day "too many people" in several parts of the world and the belief is gaining ground that only by "technicalization", that is, by becoming industrial, can a balance be effected. In the British Empire we have perhaps opposed the trend too long; the Dominions at least are resolute in their intention to establish industries. It is true that their products cannot compete for cost and even for quality with those produced at home on a large scale and with long experience, but the Australian is prepared to put up with this and to tax English products to make them competitive in order to have work for his people.

The industrial apparatus of the world is already over-developed, and the older countries were, before the war, meeting with difficulties in selling their goods. Indeed it is clear that the solution of the over-population problem is to be sought least of all in the establishment of highly technical 'machine industries'.

The greatest possibilities in the Balkan countries lie in the introduction of crops which require intensive labour for their cultivation, such as tobacco, flax, hemp, rape seed, soya beans, etc., vegetables and fruit which are either easy to export or can serve as raw materials for domestic industries. Further, stable-feeding of stock can be substituted for pasture feeding. Humidity and fertility would permit much to be done in the above directions as the climate is favourable: irrigation and rational farming are claimed to make it possible to double the employment on the land and the yield per hectare in south-eastern Europe.

Such a change would take many years to perfect, but it would largely solve the Balkan population problem and at the same time cause a great increase in the purchasing power of the farmers, which in turn would react on the industries of the countries.

The low intellectual level of the population may be measured by the small consumption of paper: less than 10 per cent of that in Germany, which in turn was much less than it is in the United States. The peasants hoard their money, a custom which still more restricts the amount of capital available for development.

It is not always realized how employment is adversely affected even in England by the very great difficulty experienced in getting money for new enterprises and new factories, especially on a modest scale. The complexity and cost of modern machinery and the regulations of the Factory Act make it almost impossible to start from small beginnings as in the past. Sooner or later a method of solving these financial problems of the small manufacturer will have to be discovered.

Here also there has been a tendency both on the part of banks and individuals to sterilize credit by placing money on deposit. The Government has been forced to finance much of the capital work of rearmament, and we are undoubtedly in consequence advancing towards the nationalization of capital. The pressure of population can only be met by the existence of enough credit to provide new enterprises.

There is much talk of freedom but very little of responsibility, of which we are only just becoming conscious. Democracy has "a responsibility to guide, to understand, to upbuild and to make a world of the twenty-first century" in the words recently used by Dr. Nicholas Murray Butler. Each one of us has a part to play, a responsibility; the one to invent new processes, a second to carry them out, a third to do the manual work, a fourth to find the capital moneys for their installation, a fifth to bring the products to the public. The chain is a continuous one, the links are of equal strength; if anyone fails to do his share there will be failure of the whole, and his is the responsibility. There need not be "too many people" if the responsibility is accepted: all concerned will have to work together much more than they have in the past. This must be done willingly and not under compulsion.

GROWTH OF THE KINETIC THEORY

The Mathematical Theory of Non-Uniform Gases

An Account of the Kinetic Theory of Viscosity, Thermal Conduction, and Diffusion in Gases. By Prof. Sydney Chapman and Dr. T. G. Cowling. Pp. xxiii + 404. (Cambridge: At the University Press, 1939.) 30*s.* net.

SINCE the days when the kinetic theory of gases was founded by Clausius, Maxwell and Boltzmann, great changes have taken place in the scope and bearing of the descendent theory. Taking a wide view of its present field, the qualification "of gases" has become a misnomer. One can see that the ultimate scope of the descendent of the kinetic theory of gases must be the whole field of the properties of matter in bulk, derived from the atomic constitution of matter and from the properties of atoms and their interactions. The present scope of the theory falls short of such inclusiveness, but not so far short as to leave any doubts for the future.

The old kinetic theory of gases has thus developed into the 'atomic theory of the properties of matter in bulk'. In so doing it has bifurcated sharply into (1) the theory of the properties of matter in equilibrium, and (2) the theory of transport phenomena and other rates of change, such as chemical kinetics. The first branch is commonly called, perhaps rather unfortunately, Statistical Mechanics. It has grown out of elaborate and repeated rediscussions of Maxwell's two early theorems (1859), his distribution law for the molecular velocities of a gas in equilibrium, and the law of equipartition of energy among two sets of molecules in a gas mixture (the latter a rediscovery of a result of Waterston (1845)). The primary result of these rediscussions has been to show that the results do not depend on any special molecular properties, and so that the equilibrium state in question is independent of the mechanisms by which it is set up and preserved. Thus the field of statistical mechanics is coterminous with that of thermodynamics, and has essentially the same generality. For the same reason, statistical mechanics has proved far the easier branch in which to make rapid progress. In fact, progress has been so rapid that one may fairly say that the complete outline of statistical mechanics (the atomic theory of the properties of matter in equilibrium), including a rational derivation therefrom of thermodynamics, was sketched by Gibbs in 1901 in his "Elementary Principles in Statistical Mechanics". Advances since then have, quite literally, only been concerned with rewriting Gibbs's theory in terms of the quantum theory, and with filling in the details by special applications.

The second branch from the old stem, the theory of transport phenomena, has proved far more difficult to climb. In the nature of things, one must expect that it will be easier to determine a limit than the rate of approach to that limit. The rate, moreover, will necessarily depend on details of the mechanisms of interaction among the many systems concerned. Transport phenomena and other rates of change have been studied profoundly for all states of matter, but a great part of these studies cannot properly be classed as part of an atomic theory of the properties of matter in bulk. Phenomenological theories, of heat conduction, for example, in which a successful description is given in terms of an assumed coefficient (the conductivity), do not qualify for inclusion, since the essential feature of an atomic theory is the *a priori* evaluation of this coefficient in terms of atomic properties. Much progress in the genuine atomic theory of transport phenomena has nevertheless been made, since Maxwell's paper "On the Dynamical Theory of Gases" (1866) first formulated rigorously the discussion of a non-uniform gas. Such genuine progress has not been confined to the gaseous state or to classical transport phenomena (diffusion, viscosity, heat conduction). It is only necessary to recall the subject of chemical kinetics, which has made much progress in the gaseous, liquid and even the solid state. The mathematical difficulties, however, are very great; it is only in the atomic theory of transport phenomena in almost perfect gases (which includes, as it happens, the electronic theory of metallic conduction) that progress has been sufficiently outstanding for the theory to have achieved any appreciable perfection of mathematical form. Along this one spray of the branch, however, complete success has been reached. It is the definitive mathematical theory of atomic transport phenomena in almost perfect gases that is recorded in the book under review, in a perfection of form which is unlikely to be seriously bettered for a long time.

The stages by which this success has been achieved are recorded by Chapman and Cowling in a most interesting historical note at the end of the book. In 1866 Maxwell was able to obtain the first accurate results for the coefficients of heat conductivity and viscosity of a gas by

confining himself to molecules which interact like point centres of force repelling according to the inverse fifth power of the distance (Maxwellian molecules). For this particular model it so happens that all the integrations over the circumstances of a molecular encounter can be carried out without a knowledge of the manner in which the molecular distribution law $f(u, v, w)$ deviates from place to place in the non-uniform gas from its Maxwellian value for a uniform gas. In all other cases, a knowledge of the distorted $f(u, v, w)$ is required, and this must be provided by solving the famous integro-differential equation of Boltzmann, first formulated in 1872, or by some equivalent procedure. There matters rested until 1905, when Lorentz solved Boltzmann's equation in the special simple case required for the discussion of the thermal and electrical conductivities of a metal, treated classically. The successful treatment of this special case gave no indication, however, of how to proceed in even the simplest case applicable to an ordinary (non-Maxwellian) gas. It was not until the independent investigations of Enskog and Chapman, 1911–17, that Boltzmann's integro-differential equation for a gas was solved, and the coefficients of diffusion, viscosity and heat conduction for a gas calculated from a proper atomic model conforming to other atomic requirements. The interesting new feature of thermal diffusion (for non-Maxwellian gases) was discovered theoretically by Enskog in 1911, re-derived by Chapman in 1916, and then confirmed experimentally by Dootson. Since then a probably final polish has been given to the theory in 1935 by Burnett, who has found that the correct form of expansion to use in solving Boltzmann's equation is one in terms of Sonine polynomials.

In the body of the book this final form of the mathematical theory is presented at length and applied to actual gases. It is presented in a rather unusual vector and tensor notation described in Chapter i. This makes the following exposition somewhat severe reading, unless the reader first thoroughly masters and familiarizes himself with the notation. A powerful and compact notation is, however, essential to an elegant presentation of the many vital complicated formulæ, and the authors' novel notation appears to be most successful and completely justified.

After a preliminary description of the properties of a gas, the equations of transfer of Maxwell and the integro-differential equation of Boltzmann are derived in a general form on the assumption of molecular chaos, followed by a deduction therefrom of the equilibrium properties of a gas. Further comments on the assumption of molecular chaos will be made at the close of this review. In two short chapters transport phenomena are then discussed on the basis of the idea of a mean free path, and the weakness of this method pointed out. The main body of the book (Chapters vii-xv inclusive) then follows, giving the complete mathematical deduction of the coefficients for diffusion, thermal diffusion, viscosity and heat conductivity for simple gases and gaseous mixtures at such densities that the mean free paths are long compared with the molecular dimensions, and neglecting any quantal effects. An exposition of this classical theory has long been required; an exposition of such elegance and authority was worth an even longer wait, and this section, which is the kernel of the book, forms a notable addition to the literature of theoretical atomic physics.

The remaining sections of the book contain, moreover, important additions to the central theme. Chapter xvii gives an excellent account of the modifications introduced into the theory of transport phenomena by the quantum theory, including a sketch of the electron theory of metals, so far as the transport phenomena involved can be described in terms of a mean free path (Sommerfeld's approximation). Chapter xviii gives the necessary extension of the theory to the case of a gas of ions subject to electric and magnetic fields. This is followed by two valuable mathematical appendixes. There remains to be mentioned only one further section, Chapter xvi on dense gases, which is to my mind the one section of dubious value, and certainly not of the classical standard of permanence achieved in all other sections of the book. The idea of the discussion is to include the effect of collisions in transferring energy and momentum instantaneously through a distance of one molecular diameter, an effect which is additional to molecular transport over the mean free path. The effect naturally exists, but I cannot believe that it plays an important part in modifying the viscosity of ordinary gases to that of dense gases and liquids, though it may of course have a sensible effect in the first changes as the density increases. As presented here, I feel that the quality of Chapter xvi and its lack of generality make it rather out of place among the classical perfection of the rest of the book.

The contemplation of the theory here expounded invites some further not very profound reflections on cognate matters of theoretical atomic physics. In the first place, one notices at once that the atomic theory of transport here given, which is at first sight theoretically complete, excludes in fact all such interesting forms of transport as turbulence in boundary layers, heat convection, and eddy viscosity and conductivity on the larger scales found in the atmosphere and in tidal currents. It is easy to see that they are in effect excluded from

the theory by the assumption of molecular chaos on which the whole atomic theory of transport is constructed. The next step for a wider atomic theory in which turbulent effects in general can have their proper place must be to discard, or rather to modify, this assumption—a theoretical advance which, if it could be made successfully, should lead to results of outstanding importance.

A conclusion of general interest can be drawn from a study of this atomic transport theory and particularly from a comparison of its exact results with those of the approximate version using mean free paths, a version which effectively also ignores any change in the form of the distribution function $f(u, v, w)$. Having here the exact solution, one knows that an approximate discussion, using $f(u, v, w)$ without modification, is liable to make errors in the numerical coefficients by factors of about 2, although it gives results of the correct general form. One may safely conclude from this that errors of similar magnitude are liable to occur when a similar use is made of unmodified equilibrium theory in the study of other rates of change such as chemical kinetics. One can thus obtain a reliable warning against too complete a trust in approximations of this type, which are otherwise impossible to check in the absence of an exact theory.

My final reflection concerns the bearing of the atomic transport theory on the possibility of a very general type of extension of statistical mechanics—a possibility in which it is very tempting to indulge unduly optimistic hopes. Contemplating the general results of equilibrium theory, which may be expressed so simply by saying that the equilibrium state of a system is the state of the system of maximum probability subject to certain boundary conditions, such as given volume and given energy, one argues, why should not a non-equilibrium state be derivable almost as simply as a state of maximum probability subject to somewhat different boundary conditions, including, for example, in a conduction problem a condition of given flow of heat. The effective answer seems to me to be provided by the results of the atomic transport theory. Here we know the correct answer to the conduction problem; its dependence on atomic properties is so complex that one can scarcely believe that it can be derivable by any process much less profound than Chapman's or Enskog's analysis. The answer this analysis gives may be in fact a condition of maximum probability for certain given boundary conditions, but that by starting from this condition one can arrive at the correct result in any simple way appears to me most unlikely. To attempt to do so would be to pursue a will o' the wisp.

R. H. FOWLER.

STUDIES OF OLD AGE

Problems of Ageing

Biological and Medical Aspects. Edited by E. V. Cowdry. (A publication of the Josiah Macy, Jr., Foundation.) Pp. xxx + 758. (London: Baillière, Tindall and Cox, 1939.) 45*s*.

"THIS volume on the process of ageing has been sponsored by the Josiah Macy Foundation in continuance of its interest in degenerative diseases and in the hope of focussing attention upon a problem which has far-reaching scientific and social implications for a society with a rapidly increasing proportion of older men and women." So runs the introduction to a volume of a new character.

In our generation we have not yet thoroughly appreciated all the problems involved in the increase in the gerontocrasy, due to improved health and other factors. Is old age a blessing? This volume is written by a group of experts and attempts to deal with the whole range of problems affecting old age. The contributors are E. Allen, L. B. Barker, W. B. Cannon, A. J. Carlson, A. E. Cohn, E. V. Cowdry, M. Critchley, W. Crocker, J. Dewey, L. I. Dublin, E. T. Engle, J. S. Friedenwald, S. R. Guild, G. V. Hamilton, L. O. Howard, A. C. Ivy, H. S. Jennings, E. B. Krumbhaer, K. Landsteiner, C. M. McCay, W. MacNider, W. R. Miles, J. Oliver, T. W. Todd, F. D. Wiedman, and C. Wissler.

Starting with chapters dealing with the ageing of plants, in which we learn that trees may live as long as 7,000 years, the book works through Protozoa and insects to vertebrates and man, dealing not only with longevity records but also with more psychological questions such as human cultural levels.

Some chapters follow upon various tissues of the body in detail, such as skin, the endocrines and the reproductive systems. Last come discussions of a more general nature, among which we may mention change in personality with age, and seniority from a clinician's point of view.

As may be expected, there is some unevenness

in treatment, but the editor has been successful in keeping this to a minimum, and producing a readable continuum. It is invidious to select from such a work, but mention may be made especially of the section upon chemical aspects of growth, in which among other chemical points, a reference is made to the startling experiments which have shown that the life-span of rats may be altered by diet. In a generation when all eyes are turned towards the attempt to improve rapidity of growth, it is revolutionary to have observations which hint that such speed may not be good for longevity.

The level of writing is high and there is much information presented, so that the book necessarily forms a standard work of reference. The printers must be congratulated upon an excellent standard of production.

CHEMISTRY OF CHEMICAL WARFARE

The War Gases

Chemistry and Analysis. By Dr. Mario Sartori. Translated from the second enlarged Italian edition by L. W. Marrison. Pp. xii + 360. (London: J. and A. Churchill, Ltd., 1939.) 21*s*.

THE first Italian edition of this work was published in 1933, and in 1935 there appeared a German translation by Dr. Klumb which was reviewed in NATURE of April 11, 1936, p. 598. A considerable number of books on gas warfare have been written in the last twenty years, but they mostly deal with its military and medical aspects and give comparatively little information about the chemistry of war gases. Dr. Sartori, on the contrary, confines his attention mostly to the chemistry of these substances, but also deals briefly with some of their other properties.

In this second edition, the author has introduced a few pages on the physiopathological properties, and then has dealt in a general way with the physical properties, especially the vapour tension and the related properties: volatility, boiling point and persistence. The volatility is defined as the weight of the substance contained in a cubic metre of saturated vapour at a certain temperature. Consequently, it must be proportional to the product of the vapour tension and the molecular weight. On pp. 6 and 7, however, there are tables of the vapour tension and volatility respectively, and it is evident that the figures are not proportional, even when allowance is made for the differences in molecular weight. At the end of the book there is a more extensive table in which these two properties are given in adjacent columns, and the same discrepancy appears again. Apparently, some of these volatilities were calculated from values for the vapour pressure very different from those given both in the tables and in other parts of the book. It is remarkable that this fairly obvious error has been repeated from the first to the second Italian edition, and has not been noticed by either the German or the English translator. There is a similar discrepancy in the persistences of dichloroethyl sulphide (mustard gas) and bromobenzyl cyanide (*CA*) as given in the table on p. 11.

In the last line of the last table on the last page of the text the molecular weight of phenarsazine cyanide, $NH(C_6H_4)_2AsCN$, is given as 272·0, whereas the German edition gave it as 272·9. The correct figure is 268.

Numerous additions have been made in the second edition; the substances dealt with have increased from forty-nine to sixty-four, but the additional fifteen war gases do not appear to be of much practical value and have evidently been introduced to make the work more complete. It is not to be expected that important new developments will be published at present. After the War of 1914–18 much of the accumulated information was released, but the international tension during recent years has led to a return to secrecy. It is also improbable that much advance, if it can be called advance, has been made by the various chemical 'defence' research institutions, as there is no satisfactory method of testing these poisons. They cannot be tried on human beings except in mild doses, and the results with animals may be quite different. The Germans published the results of tests with cats, and more recently the Americans have released some results with dogs and mice. As might be expected, the results do not run parallel.

There is a good deal of additional information in this edition, and there must now be about a thousand references to original papers. The book is evidently the result of years of work and will be found an indispensable guide through the scattered literature of the subject in spite of some inaccuracies in the numerical data. For each substance the available information is given of the properties, laboratory preparation, manufacture and analysis. The translation has been well carried out and the get-up is good, as it is to be expected from the firm of Churchill.

ARTHUR MARSHALL.

RESPIRATORY ENZYMES

Respiratory Enzymes
By University of Wisconsin Biochemists, under the direction of C. A. Elvehjem and P. W. Wilson. Pp. v + 236. (Minneapolis: Burgess Publishing Co., 1939.) 3.25 dollars.

THE rapid developments during recent years in our knowledge of respiratory enzyme systems have created a demand for a book which, whilst giving an accurate and coherent account of these developments, indicates the nature of the experimental work leading up to them and shows the manner in which they are interrelated. Much of the relevant information which has been summarized so far, is to be found in authoritative but somewhat scattered review articles. It would obviously be a convenience to the student and to the experimental worker to have at hand a reasonably accurate account of the present state of the subject, in which sufficient of the older work is discussed to provide a proper perspective for the appreciation of the value of recent contributions.

The volume under review presents such a summary. It consists of a series of articles, reproduced from typescript, bearing on various aspects of respiratory enzyme systems, each article being written by a member, or by a number of members, of a group of workers engaged in enzyme research at the University of Wisconsin. A historical introduction to the subject by Prof. Elvehjem is followed by chapters on dehydrogenases and oxidases. Then come articles on coenzymes, cytochrome, flavoproteins, etc., an article on the specific and non-specific poisons of respiratory processes and one on hydrogen transport systems. Finally, there are useful chapters on oxidation-reduction potentials, and on the physical-chemical theory of enzyme reactions.

The chapters vary considerably in style and in the thoroughness with which their subject-matter has been treated. Some overlapping has been inevitable. The volume has obviously been compiled with great care, and the reviewer has noticed no misrepresentations of fact or of interpretation. The book should be very helpful to the student and to the worker about to commence research on respiratory enzyme systems. J. H. Q.

THE FAUNA OF THE SEASIDE

The Littoral Fauna of Great Britain
A Handbook for Collectors. By Dr. N. B. Eales. Pp. xvii + 302 + 25 plates. (Cambridge: At the University Press, 1939.) 12*s.* 6*d.* net.

A COUPLE of generations ago, the science of zoology ran a serious risk of being embedded in paraffin. This calamity was happily averted, and the young naturalist hies again to the seashore; but the first line of Dr. N. B. Eales's preface suggests that the poisonous breath of the examiner follows him even there. It may be so; but the fresh air, and the spirit of Edward Forbes and Sir John Graham Dalyell cleanse and sanctify the place, and keep it as sweet as ever. In Edward Forbes's day and for years afterwards, we led the way in the literature of natural history. Forbes and Hanley, Yarrell's "Birds" and Gould's, the early British Museum catalogues, the Ray Society volumes and the Challenger Reports had no rivals. Alas, it is not so now. We might have undertaken the new "Systema Naturæ", but Berlin took the "Tierreich" in hand. There is a "Fauna of the North Sea", but it is written in German; there is an excellent "Faune de France", but none of the British seas.

Dr. Eales has not attempted the task, too big for one pair of hands, of writing a British Fauna, but she has compiled a careful and copious account of the fauna of the sandy beach and the rock-pools; and the shore-fauna is liberally interpreted, for while the sea-mouse must stay outside, the feather-star and the purple heart-urchin, and pinna and the oyster itself are allowed to enter in. Philip Henry Gosse did the same thing more than eighty years ago, and the two little green volumes of his "Manual of the Marine Zoology for the British Isles" were used and loved by many. His plan was different from Dr. Eales's; for he included all the species as best he could but only defined the genera, while Dr. Eales defines the species, but only a selection of these. Gosse's illustrations were the best part of his book; they were only thumb-nail sketches, but they were

drawn from life, and every one is unmistakable. The "littoral fauna" defines itself; and yet it took Edward Forbes to show its peculiar character. How in doing so he made good use of Örsted's "De regionibus marinis" and Audouin and Milne-Edwards' "Recherches pour servir à l'histoire naturelle du littoral de la France"; and how very beautifully he himself wrote about it all, and especially about his own so-called "Celtic province", is an old story and a fine chapter in the history of science.

To write like Edward Forbes or to draw like Gosse is no longer given to mortal man. But after the fashion of our own day Dr. Eales has done her work well and handsomely, and many a student will find precisely what he wants in her book. I would cavil over one thing only—the extreme correctness, or modernity, of Dr. Eales's nomenclature. When Dr. Marion Newbigin wrote her "Life by the Seashore" she apologized for keeping to many old-fashioned and familiar names, without which such a book as Gosse's "Sea-anemones" could no longer be understood. But Dr. Eales will have no half-measures; we must call the once familiar Trochus millegranus *Cantharides clelandi*, and Saxicava rugosa *Hiatella gallicana*, and so on, whether we like it or no.

D. W. T.

MORE ABOUT MICROBES

Microbes by the Million

By Hugh Nicol. (Pelican Special, S28.) Pp. 248 + 8 plates. (Harmondsworth, Middx.: Penguin Books, Ltd., 1939.) 6*d*.

THIS is a wonderful six-pennyworth, and a very interesting and instructive little book. It is written in simple language understandable by ordinary folk, with a considerable sense of humour, and conveys much accurate information on microbes, what they are and what they do.

Commencing with an introduction dealing with the nature of microbes and describing their several kinds—fungi, protozoa, bacteria and algæ—successive chapters deal with the phenomena of their life and the processes associated with their growth and development. In the last hundred pages, chapters are devoted to microbes in the home, in the soil and in the garden, the mechanism of formation of fairy rings, the discharge of its spores by the fungus Sphærobolus, the miracle of the bleeding host, and to a microbe foray on the Norfolk Broads.

Chapters at the middle of the book deal with laboratory technique, and a number of simple experiments are described for the study of microbes in the soil and their influence upon plant and crop life and development, and on the microbiology of disinfectants. All this is set out in interesting fashion, and the reader who has mastered the contents of this little book should have a good idea of the essentials of microbiology and of the importance of microbes for the growth of plants, in the firing of hay-stacks and in the production of silage, and as sources of certain perfumes, drugs, dyes, foods and drinks. A brief but useful chapter is also devoted to stereochemistry—'looking-glass chemistry' as the author terms it—and Pasteur's work on the tartaric acids is related. No errors of moment have been detected, and the book is adequately illustrated with a number of line drawings and six excellent plates.

On the pasteurization of milk (pp. 138–140), the author tells but a part of the story, and gives an unfair and inaccurate idea of the objects of the process. Professors do not seem to meet with his approval (p. 52), nor do doctors and the medical profession, who are arrogant and ignorant, and—most unkindest cut of all—concerning milk pasteurization, have "become allies of the merely commercially-minded wholesalers, which may seem strange unless one understands medical mentality (p. 139)". A more kindly outlook might have been expected, for soil microbiologists owe much to the work of medical bacteriologists.

We gather that the author in writing this book intended not only to instruct his readers in soil and general microbiology, but also desired to extend the 'philosophy' of microbiology to science in general, and to impart ideas on the impacts of science upon the social order. In an epilogue, he discusses experimentation and the various meanings given to the term 'experiment', and the value of statistical analysis of experimental work, but we think that in his illustrative examples he is less happy than in other parts of the book. His remarks on company finance and on the 5½ per cent *C* stock of the London Passenger Transport Board, introduced in discussing ratios, also seem out of place and ill-conceived.

With these few criticisms, we leave the book in the hope that it will be widely read and appreciated.

R. T. HEWLETT.

PRELIMINARY RESULTS OF THE MARKING OF WHALES BY THE DISCOVERY COMMITTEE

By GEORGE W. RAYNER

FROM the outset of its investigations, the Discovery Committee has considered whale marking to be a method of considerable importance in approaching many of the problems to be solved in a study of the life-history of whales. It was, however, found difficult to design an efficient mark, and it was not until 1932 that a suitable form was produced. The mark then adopted consists of a stainless steel tube fired at the whale by means of a 12-bore gun ; it is designed to penetrate the blubber and to remain embedded until the whale is captured and dismembered by the whalers. This form of mark was given a trial during the whaling season of 1932–33 and the results forthcoming during the ensuing year were so encouraging that an extensive programme of whale marking was planned and carried out during 1934–35 and the three following seasons.

In 1934 the Committee's ship, the R.R.S. *William Scoresby*, was commissioned solely for whale marking purposes and spent the whole of the 1934–35 season on the Antarctic whaling grounds lying eastwards of the Greenwich meridian and extending almost as far as the longitude of Western Australia. At the same time a hired whale catcher operated for about six weeks in the middle of the season from South Georgia, where the area covered was much more restricted. This programme, with the *William Scoresby* working for the whole season on the pelagic grounds to the east and the whale catcher covering a small area around South Georgia in an intensive manner, was repeated during the following two seasons, 1935–36 and 1936–37. In 1937–38 the programme was modified ; only the *William Scoresby* operated and her work was planned to fill in gaps and to amplify, in the light of results already obtained, that accomplished previously. She commenced earlier in the season to the north of South Georgia and worked eastwards to the Greenwich meridian, then westwards again along the ice edge before the whaling season commenced. She then marked whales across the mouth of the Weddell Sea and made two incursions into the Bellingshausen Sea.

On Chart I is depicted the distribution and intensity of the marking carried out since 1932–33. There is an area of intensive marking around South Georgia, with a small area around the Shag Rocks, 120 miles westward of the northern point of South Georgia, where very many whales—more than six hundred—have been marked. There are further two extensive areas in which relatively large numbers of whales have been marked, one off Queen Mary Land (85° E.–95° E.), and a second off Enderby Land (15° E.–50° E.). In addition, whales in lesser numbers have been marked over an immense area connecting and extending the regions of more intensive marking ; on the chart the continuous longitudinal lines show where this marking has been relatively dense, the broken lines where it has been scattered. The areas of more intensive marking correspond to some extent with the grounds mostly frequented by the whalers.

The whales supporting the Antarctic whaling industry are, in order of their importance, Blue, Fin and Humpback, the last being relatively unimportant. The majority of the Humpback whales marked have been found off Queen Mary Land. Whales marked around South Georgia have been predominantly Fin, and in the area around the Shag Rocks exclusively so.

Numerically the results are given in the following table :

Species	No. marked	Returns	
		No.	%
Blue	668	33	4·94
Fin	3902	118	3·02
Hump	548	36	6·59
Sei	28	—	—
Right	8	—	—
Sperm	56	—	—
Totals	5210	187	—

In addition to the three commercially important species, it will be seen that an insignificant number of the less important and rarer species have also been marked. The number of marked whales reported as captured is 187, and these have been taken at intervals after marking varying from a few hours to fifteen hundred days.

Since it is not certain how many marks drop out or are missed by the whalers, the percentage figures are not an absolute indication of the percentage of marked whales killed, but they are very instructive as to the relative effect of whaling on

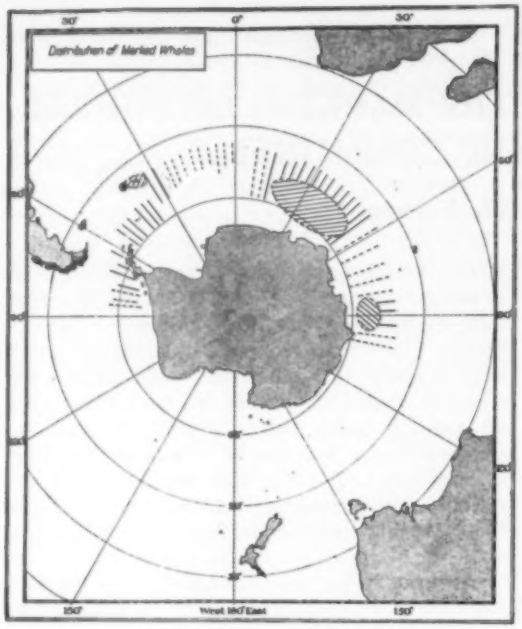


CHART I.

the stocks of the different species. The Blue whale is the species most eagerly sought after by the whalers, although the Fin whale is far commoner. The percentage figures show how the stock of Blue whales is being depleted at a considerably faster rate than that of Fins—5 per cent of the marked Blue whales have been reported killed as opposed to 3 per cent of the marked Fin whales. The percentage of marked Humpbacks taken compared with the figures for the other two species is striking, and it is evident that this whale is being killed off at a surprisingly faster rate than the other two. Soon after whale marking commenced, whaling during the southern winter was resumed off the north-west coast of Australia. This fishery is based on Humpbacks and considerable numbers were taken. Marks recovered showed that these whales were of the same stock as those marked in Antarctic waters off Queen Mary Land (see Chart II). This stock of whales was, therefore, exposed to a double persecution which accounts for the comparatively high percentage figure of returned marks. Still more recently whaling, again exclusively based on Humpbacks, has broken out during the winter season to the south of Madagascar. This double persecution of Humpback whales, which their habits render particularly easy, cannot fail to have a very marked effect on the comparatively small stock, which is bearing a burden relatively more than double that of the Fin whale stock and considerably higher than that of the Blue stock, already regarded as overtaxed.

The marks recovered have yielded a great deal of information on the movements and migrations of the three commercially important species. Very little indeed had been known previously about the wanderings of whales, and what has been conjectured has rested almost wholly on circumstantial and indirect evidence. The recovered marks demonstrate two main general features of whale movement, complementary or contradictory in character as one may care to consider them. On one hand, whales return to the same part of the Antarctic season by season on regular tracks of migration—they may be said to have a strong homing instinct. On the other hand, they tend to spread around the Antarctic from one region to

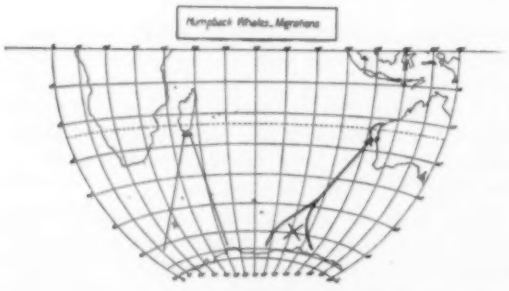


CHART II.

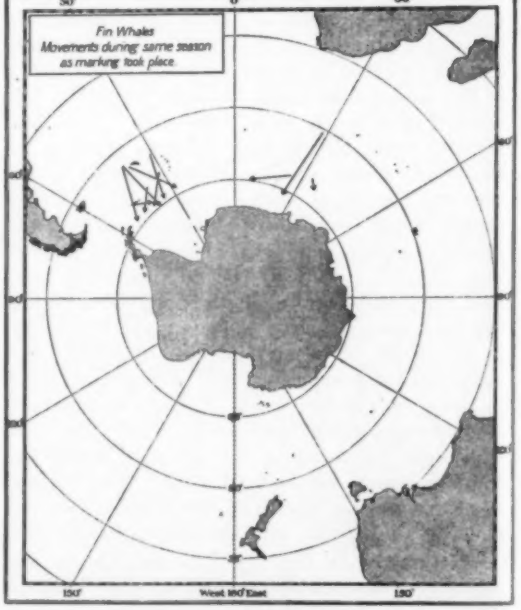


CHART III.

another, a form of movement going on slowly and gradually and so far only demonstrable among Blues and Fins. One might say that, among the general body of whales keeping to their regular channels of movement, a few are affected with a wanderlust leading them to seek new oceanic pastures and fresh companions.

On the accompanying charts the general trends of movement and migration are indicated by the arrows, the crosses show places where whales have been taken very near the position where they were marked. Possibly more was known about the migrations of the Humpback whales than of any other species, and a north and south migration along the western coast of Australia has been conjectured for some time past. Marking has confirmed this and has demonstrated almost the full course of this migration. Humpback whales marked in the Antarctic have been taken in the southern winter off the north-west coast of Australia after intervals up to three and a half years, whilst they have appeared in the southern summer on the Antarctic grounds near Queen Mary Land one, two and three years after marking. One may confidently say there is an annual north and south migration of Humpback whales along the track shown on Chart II. In the western part of the Indian Ocean a similar north and south migration evidently exists between the Antarctic and the region of Madagascar. There is shown the return to the same area of the Antarctic and the recovery

CHART IV.

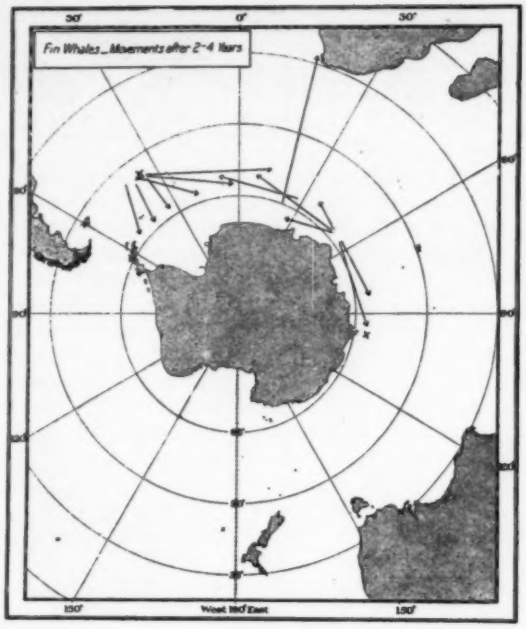


CHART V.

in the tropics during the southern winter. It is most noteworthy that there has been no interchange of Humpbacks between these two regions.

The movements of Fin and Blue whales have been plotted on the accompanying charts according to the time elapsing between marking and capture. Chart III gives the movements of Fin whales during the course of the whaling season, and it shows a general movement southwards towards the edge of the pack ice. A number of Fin whales marked around South Georgia have been taken there during the same season, but never after an interval longer than a few days, so one may consider Fin whales found in these waters to be migrating whales. Further, none of the large numbers of Fin whales marked near the Shag Rocks has been taken the same season by the South Georgia whalers, so there can be little easterly movement here during the season. There is strong evidence that there are regular tracks along which different bodies of Fin whales move on their migrations southward, and it is probable that these tracks may shift a little from season to season.

The movements of Fin whales after a year's time are shown on Chart IV. There has been in many places a return to the same place as marking took place. Further, some arrows show movements which mean essentially a return to the same area both in the east and in the South Georgia – Weddell

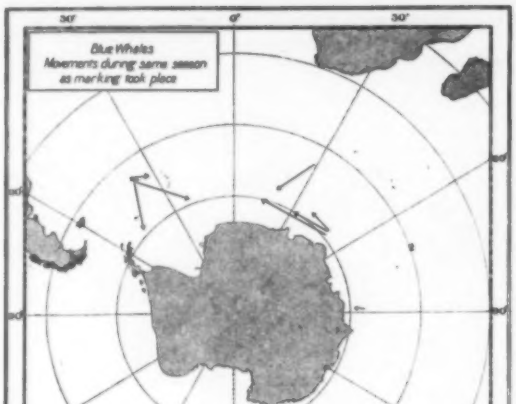


CHART VI.

Sea region. Whales marked around the Shag Rocks have turned up in force near South Georgia and many have been taken to the south again, evidently repeating their movements of the previous year. But wider movements are to be seen, indicating the beginning of spreading. Whales have come into the Scotia Sea area from regions as far apart as the Bellingshausen Sea and the neighbourhood of Bouvet Island, whilst a considerable movement outwards towards the east has taken place.

After longer periods, Chart V, the same description holds good, but the spreading movement is gathering force. There is still a return to the old grounds, but whales have spread outwards from the Enderby Land region eastwards and westwards, and the eastward movement from South Georgia has progressed farther. There are now links connecting more than 180° of longitude, but this movement around the Antarctic may be likened to a relay race in which no individual competitor completes the whole course; in fact, it may be suggested that a complete circumnavigation of the continent may take more than a single generation. The significance of this is that whilst the Fin whales of the Antarctic remain specifically one stock, economically several distinct local stocks may be recognized.

One marked Fin whale has been taken at Saldanha Bay, South Africa, after 2½ years, and this is the first direct evidence of the migration of Fin whales from the Antarctic towards the tropics. This whale is of particular interest, for when marked it was logged as a calf accompanying its mother.

The movements of Blue whales are in many respects very similar to those of Fin whales, but the picture is not so clear. Around South Georgia many marked Blue whales have been taken the same season as they were marked, but never after an interval longer than a week, so Blue whales found here must be on the move and do not remain long in the vicinity of the island. Their general movement is southerly and to the west or east (Chart VI). This same general southerly movement is shown on the grounds to the east, but off Enderby Land there is strong evidence of a definite westward moving stream of Blue whales.

After one year, Chart VII, there are returns to the same area as was visited the previous season, but there is also considerable spreading. Enderby Land whales now show considerable movement to the east which may be considered complementary to their westward movements during the summer. After longer periods of time the spreading movements shown are actually less than those for the period of about twelve months, but throughout the homing instinct is well maintained; it is easy to see that mixing between the different regions is going on quite slowly, although it is sufficient for the identical specific characteristics to be retained throughout the whole population.

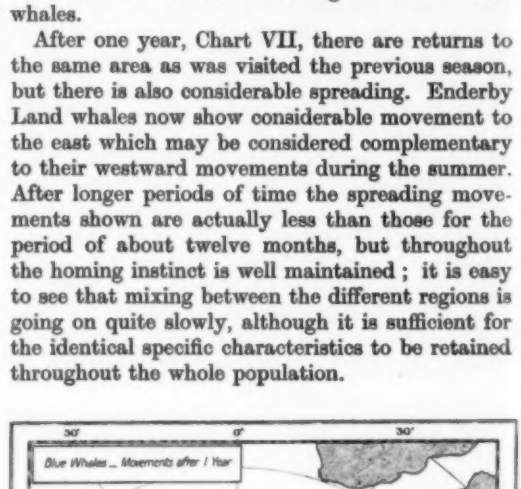


CHART VII.

THE ANTIMONY TREATMENT OF KALA-AZAR

By SIR LEONARD ROGERS, K.C.S.I., C.I.E., F.R.S.

THE progress during the last quarter of a century, due to many workers, in the treatment of the deadly kala-azar of north-east India and the Mediterranean basin has not attracted the attention it deserves. The epidemic form spread two hundred miles up the Brahmaputra Valley in the last two decades of the nineteenth century, with a case mortality of 96 per cent, and it caused a reduction of 31·5 per cent in the population of the Nowgong district in one decade. In 1890 G. M. Giles incorrectly reported kala-azar to be due to hookworms; in 1897 L. Rogers failed to differentiate the fever from malaria, but established a house or site infection, which enabled Dodds-Price to stamp it out of tea estates. The extension of the epidemic to the east was thus checked for two decades, until the influenza outbreak of 1918 caused kala-azar to break out again in the Sibsagar district.

In 1903 Leishman and Donovan independently discovered the human stage of the causative protozoal parasite (*Leishmania donovani*), which Ronald Ross called after them when the flagellate stage was discovered by culture by Rogers in 1904. Work in the Calcutta Medical College hospital also proved that the malarial cachexia of Twining (1835) is nothing but a sporadic form of kala-azar. The very similar *Leishmania tropica* is the cause of oriental sore, and it was the discovery in 1913 by Vianna in Brazil of the effectiveness of tartar emetic intravenously in that infection that led to its successful trial in the Mediterranean in infantile kala-azar in Sicily by Cristina and Caronia reported early in 1915. Rogers immediately reported that he had independently obtained good results with tartar emetic in the India kala-azar after trying other antimony preparations, and in October 1915 both he and Muir published their results. Further trials showed that both sodium-antimony tartrate, and a colloidal solution of antimony sulphide, made by Fisher of the Madras Educational Service, were equally effective and rather less toxic than the potassium salt.

This important discovery came in time to enable McCombie Young to control the Sibsagar outbreak through two to three months' intravenous injections of tartar emetic in 80,000 village cases in Assam by 1921, with a recovery rate of 88 per cent, against 4 per cent in the early Nowgong epidemic. Moreover, the next census showed no fall in the Sibsagar population. Muir also found that systematic treatment of cases in the Kulna hospital led to the disappearance of cases coming from the surrounding villages, and thus kala-azar became an easily controlled disease, given sufficient medical staff, as tartar emetic is very cheap.

It remained for the chemists in India and Europe to seek for even more efficient antimony preparations, and they naturally turned to the less toxic pentavalent ones. The first of these was introduced (and patented) by Dr. U. N. Brahmanchari in Calcutta in 1921, under the name of urea stibamine. This proved less toxic and more effective, and it enabled more than 90 per cent of cases to be cured by intravenous injections within a few days, although so late as 1928, R. N. Chopra, professor of pharmacology in the School of Tropical Medicine, Calcutta, reported this preparation to vary widely in its antimony content and to be uncertain in its composition. In the meantime, von Heyden in Germany prepared a series of pentavalent antimony salts, which were comprehensively tested by L. E. Napier in the hospital of the Calcutta School of Tropical Medicine. Both von Heyden 471, or stibosan, and 693, neostibosan, proved effective, and the latter proved to be the best, with more than 90 per cent of cures after eight daily intravenous injections. In 1937 a final advance was made by the introduction by Kikuth and Schmidt of solulostibosan, which Struthers and Lin in China, and Yates and Napier in Calcutta, found to be equally effective by the much more convenient intramuscular injections, especially in the young children so frequently attacked by kala-azar.

The value of neostibosan is shown by a systematic treatment of all the kala-azar cases in a group of Bengal villages by Napier, with a reduction from 121 and 127 in the first two years, to 12 and 3 in the fifth and sixth years and later to nil. Further, between 1923 and 1933, the Assam Government treated more than 300,000 cases, and relied largely on urea stibamine, which was adopted as the preferable drug in 1935. Between 1925 and 1936 the treated cases in Assam fell to one sixth and the deaths to one ninth of the former rate.

Unfortunately for such a poor country as India, the more rapid effects of the pentavalent preparations over the original trivalent tartar emetic is offset by a curative course of the former costing 160 times as much as the latter, according to Napier, who in 1925 found a course of stibosan to cost £2 5*s*. and one of urea stibamine £3—a

prohibitive sum for poor villagers in India. Napier found the village cases near Calcutta to amount to 33 per thousand population, a rate which would give one million in Bengal. The true number must be much less, as in large areas the prevalence is far less than near Calcutta. Owing to their much more scattered distribution in Bengal than in Assam, and the absence of qualified doctors in Indian villages, the problem of treatment in Bengal is more difficult, and requires for its solution a far cheaper preparation, which is equally effective as the pentavalent antimony ones. With such a drug and sufficient village medical staff, kala-azar could be reduced to small proportions.

OBITUARIES

Sir William Prout, K.C.M.G., O.B.E.

THE death of Sir William T. Prout occurred on November 18, at his residence at the Manor House, Lingfield, Surrey. He was born in 1862, the son of Mr. William Prout of Mauritius, and was educated in the University of Edinburgh, graduating in medicine in 1884. He served as a medical officer in Mauritius until his transfer as an assistant Colonial surgeon under the Colonial Office in the Gold Coast in 1888, serving later in the Gambia until his promotion to the post of principal medical officer in Sierra Leone in 1895, where he was an official member of Legislative Council until his retirement in 1906.

During his service in these territories, Prout acquired valuable knowledge and experience in the treatment of tropical diseases, publishing original papers on yaws ("Diseases of Warm Climates" Davidson); *Filaria volvulus* (*Arch. Parasit.*, May 1901); filariasis in Sierra Leone (*Brit. Med. J.*, 1902), etc. He was actively interested in the preventive aspect of tropical medicine, and in the improvement of conditions of life for both Europeans and natives. It was largely due to his initiative that application of the principles of tropical sanitation became increasingly employed in West Africa and elsewhere, with the corresponding improvement in life and health which has been such a marked feature in the early years of this century.

Following his retirement from West Africa in 1906, Prout became honorary lecturer in tropical medicine in the University of Liverpool. He was appointed medical adviser to the Colonial Office in 1912, and later became consulting physician to the Colonial Office until his retirement in 1929, serving during the War of 1914–18 with the R.A.M.C. in Egypt, and being twice mentioned in dispatches. He was one of the original members of the Advisory Medical and Sanitary Committee of the Colonial Office of which he remained a member until his death, and was an ex-president of the Tropical Section of the Royal Society of Medicine, a fellow of the Royal Medical Society, Edinburgh, and a fellow of the Royal Society of Tropical Medicine.

The honour of C.M.G. was conferred on him in 1905, that of knighthood in 1924, and K.C.M.G. in 1928, while he also received an O.B.E. (military) for his war service.

He married Miss Mary Mackenzie in 1888 and had two children, a son being killed during the War of 1914–18.

A. E. HORN.

Mr. P. H. Grimshaw, I.S.O.

PERCY HALL GRIMSHAW found the bent of his life when in 1895 he forsook a clerk's stool in a bank in Leeds to fill a post in the Royal Scottish Museum in Edinburgh. His earlier interests had been botanical, but the chance that, of his colleagues in the Natural History Department, Dr. R. H. Traquair was particularly interested in fossil fishes and Dr. Eagle Clarke in birds and mammals, turned his attention to the lower forms of animal life, and he singled out for investigation the insects and particularly the Diptera. His papers, mostly published in the *Annals of Scottish Natural History* and its successor the *Scottish Naturalist*, which for many years he assisted in editing, added greatly to the knowledge of the distribution of insects in Scotland, and he travelled widely on the mainland and in the outer islands to collect material for his "Diptera Scotica" and other contributions.

One of his interesting discoveries was the presence in Great Britain of a bot-fly (*Cephenomyia rufibarbis*) parasitic on red-deer, and his study of the life-history of the destructive heather-beetle (*Lochmæa suturalis*), made in connexion with the Committee of Inquiry on Grouse Disease, suggested the few measures of control which seem to be possible.

When he was appointed keeper of the Natural History Department of the Royal Scottish Museum in 1930, Grimshaw continued the development of the educational appeal of the exhibits, and under his supervision was created a Children's Gallery which for the attractiveness and suggestiveness of its collections would be difficult to beat.

On his retiral from the keepership in 1935 he was decorated with the Imperial Service Order. He died suddenly on November 14, at the age of sixty-nine years.

JAMES RITCHIE.

Prof. Anton von Eiselsberg

PROF. ANTON FREIHERR VON EISELSBERG, the eminent Vienna surgeon, who died last October, was born at Steinhaus in Upper Austria on July 31, 1860. He received his medical education in Vienna, Wurzburg, Zurich and Paris, and qualified in Vienna in 1884. After serving as assistant to Prof. Billroth, the pioneer in visceral surgery, he was appointed successively professor of surgery at Utrecht (1893), Königsberg (1896) and Vienna (1901), where he retired in 1931. Besides being a first-class operator and a

remarkable teacher, he was the author of numerous experimental and clinical publications, of which the most important were on the occurrence of tetany after operations for goitre (1890), diseases of the thyroid (1903), and the modern treatment of fractures (1905). He was also co-editor of the *Archiv für klinische Chirurgie*, which dedicated to him its 140th volume on the occasion of the twenty-fifth anniversary of his professorship in 1926, and of the *Mitteilungen aus der Grenzgebiete der Medizin und Chirurgie*. During the War of 1914–18, in which he was appointed consultant to the Austro-Hungarian Navy, his services were much in request especially as regards abdominal wounds and amputations.

Eiselsberg had many friends in Great Britain, where he was elected Hon. F.R.C.S. Edin. in 1905, Hon. F.R.C.S. England in 1913, where he delivered the Hunterian Lecture in 1932, and honorary fellow of the Royal Society of Medicine in 1928. His autobiography, under the title of "Lebensweg eines Chirurgen", appeared a few months before his death.

J. D. ROLLESTON.

Prof. R. I. Meyer

PROF. RICHARD I. MEYER, whose death, at the age of seventy-four years, occurred on June 18, was one of the best known inorganic chemists in Germany. Born in Berlin on August 24, 1865, he built up a reputation early in life by his researches on rare earths, thallium and scandium; his discovery of scandium in tungsten and tin slags enabled him to produce this element—then considered one of the rarest—in sufficient quantity for its thorough chemical and physical investigation. From 1897 onwards, for twenty-five years, Meyer was associated with Prof. Arthur Rosenheim in Berlin in the conduct of a private scientific chemical laboratory in which, under the guidance of these two men, university students carried out valuable research work in inorganic chemistry—a branch of chemistry frequently neglected in the official university laboratories in Germany, which were almost without exception directed by organic chemists.

On his retirement from this laboratory in 1922, Prof. Meyer was entrusted by the German Chemical Society with the organization of the eighth edition of "Gmelin's Handbook of Inorganic Chemistry" which, in this new form, is as outstanding in its field as is the famous "Beilstein" handbook in organic chemistry. The achievement of this high standard is due to the comprehensive editorial programme laid down by Meyer, to his discriminating choice of co-workers, and to his careful supervision of every detail in the publication of the first twenty or so volumes. Even after withdrawing from the editorship, he helped by writing the manuscript of the introductory volume on rare earths; his name, however, was omitted from the title page when the volume appeared in print—a fate which quite frequently befell 'non-Aryan' authors in Germany after 1933.

Not only in his editorial activities were Prof. Meyer's organizing abilities of high value, but also in his work as one of the members of the International Committee on Atomic Weights—for the reports of which he was largely responsible—and as a member of the International Committee on Inorganic Nomenclature. Everybody who came in touch with him was delighted to find not only a chemist of wide erudition and outlook but also a highly cultivated man of great personal charm who was as interested in questions of art, especially music, as in science. It was a matter of intense pleasure and pride to him to see this part of his inheritance come to full development in his highly gifted only son, who became a successful orchestral conductor.

No obituary article on the work of this excellent chemist appeared in any German journal; no official representative of the German Chemical Society attended the funeral of the man who had so devotedly worked for many years in the society's publishing offices. Nevertheless, his name will be gratefully remembered inside and outside Germany as the first editor-in-chief of the new "Gmelin" by present and future generations of chemists who will consult this monumental work.

Prof. F. Y. Loewinson-Lessing

SCIENCE, not only in the Soviet Union, but also the world over, has suffered a great loss in the death on October 24 of Prof. F. Y. Loewinson-Lessing, member of the Academy of Sciences of the U.S.S.R. and director of the Petrographical Institute in Moscow.

Franz Youlievich Loewinson-Lessing was born in St. Petersburg on March 9 (February 25, Old Style), 1861. After graduating in 1883 at the University of St. Petersburg, he worked for some years as an assistant at that University. In 1892 he was appointed professor of geology, petrology and mineralogy at the University of Dorpat (Youriev) and in 1902 was the first holder of the chair of geology, petrology and mineralogy in the newly founded St. Petersburg Polytechnic Institute. In 1925 he was elected a member of the Russian Academy of Sciences and director of the Geological Museum. He was the founder and first director of the Petrographical Institute. He was an honorary or foreign member of a number of scientific societies at home and abroad, including the Geological Society of London.

Prof. Loewinson-Lessing was the leading petrologist in Russia and was well known internationally. The bulk of his work was published in Russian, but he also contributed quite a number of papers to English, American, French and German periodicals. Although his main interest was in the petrology of igneous rocks, he published a number of papers dealing with mineralogy, geology and ore-deposits. His books include "Tables for the Determination of Rock-forming Minerals" (English translation, 1893), "Petrographical Tables" (1905, 1911), "Text-book of Crystallography" (1911, 1923), "Introduction to Geology" (1923), "Progress of Petrology in Russia" (1923), "Petrology" (1925), "History of Petrology" (1936, English translation forthcoming). Altogether he was responsible for more than two hundred papers and books.

Prof. Loewinson-Lessing's field work covered almost the whole of the territory of European and Asiatic Russia. He began his work in Karelia and the Caucasus and then extended his activity to the Crimea, the Ural Mountains and Siberia. His petrographical descriptions of the rocks of these regions were used as models by other petrologists. Field description, petrography and petrochemistry of rocks are well blended in all his works. In the domain of theoretical petrology, he is well known for his chemical classification of igneous rocks and his syntectic-liquational hypothesis of magmatic differentiation. In spite of the stress laid by him on liquation as a factor of differentiation, his views on this subject were rather eclectic.

As a teacher, Prof. Loewinson-Lessing was excellent. It is a matter for wonder that he could, in addition to all his research activities and his official duties, contrive to hold numerous classes for students. His lectures were always inspiring and he never lost his freshness of outlook or his mastery of presentation. During a half-century of teaching he trained hundreds of geologists and petrologists. He will be affectionately remembered for his kindness and his help and inspiration by all his colleagues and pupils, among whom the present writer is proud to inscribe himself.

S. I. TOMKEIEFF.

WE regret to announce the following deaths:

Prof. Viggo Christiansen, emeritus professor of neurology in the University of Copenhagen, president of the International Congress of Neurology held last August, on November 3, aged seventy-one years.

Dr. J. F. Lewis, past president of the Royal Photographic Society, on November 28, aged seventy-two years.

Sir Ernest Scott, emeritus professor of history in the University of Melbourne, and president in 1939 of the Australian and New Zealand Association for the Advancement of Science, aged seventy-one years.

NEWS AND VIEWS

Indian Archæology and Indian Problems

SIR LEONARD WOOLLEY'S Birdwood Memorial Lecture to the Royal Society of Arts, on December 1, was in effect an addendum to his official report to the Government on the organization of archæological studies in India; and it should receive no less careful consideration than the major document when in due course it appears in print. For in the freer atmosphere of the lecture hall, Sir Leonard evidently felt at liberty to allow his trained faculty of scientific imagination to play on the archæological material which had come before him, and to submit the result to his audience in a selection of the problems and possibilities which the study of Indian archæology presents to his mind as calling urgently for investigation—problems no less fascinating in the vistas of the advancement of knowledge they open up than they are evocative of dismay when contemplation turns to the vastness of the field in time and space to be covered. Nor was any short cut offered which might lead by an easy way to the solution of these problems. While Sir Leonard paid due tribute to the work of Lord Curzon in setting up the Archæological Survey of India, and the work which has since been carried out in the triple function of conservation, excavation and publication, he went on to point out with the greatest emphasis that no further advance on sound lines is possible until the essential preliminary groundwork has been completed and a backbone has been built up in a sequence scheme of Indian cultural history. This is the essential task to which effort must first be directed.

IT was suggested in NATURE of October 28, p. 721, that the inauguration of a new era in India's history might fittingly be marked by the institution on a sound and lasting basis of a scheme of research and study on broad lines of the racial and cultural history of India. In such a scheme archæological investigation would inevitably take a foremost place. As Sir Leonard said, "The whole country from north to south is strewn with standing monuments of the greatest interest and the greatest beauty and the utmost historical value." He then pointed out that in his analysis of the cultural elements of the ancient monuments of India, certain factors had emerged, from which he proceeded to draw conclusions significant for the India of to-day. In the architecture of the monuments, he showed, the Mogul strain, working in stone, and the Dravidian, a style derivative from the technique of the worker in wood or even the jeweller, constituted a clash in styles reflecting a political and moral breach between two elements still represented in the population of to-day. Nevertheless, the clash had been resolved in the triumphs of the Taj Mahal, the Delhi fort, and more especially in Fatehpur Sikri, which showed conclusively that the genius of the two peoples "can combine fruitfully and fertilely". Novel views of the relation of north and south, thrown out as suggestions presented on the results of Sir Leonard's inspection of specified sites, offer a field of research which, when once the essential groundwork has been completed, might offer to the Indian peoples a source of unity in pride in their joint cultural achievement in the past.

School of Oriental and African Studies

NOTWITHSTANDING the transfer of the School of Oriental and African Studies of the University of London to Christ's College, Cambridge, the building of the School's new premises in the University of London area is being pushed forward, and should be

completed, if nothing untoward intervenes, by May next. It was intended that the School should open there for the session 1940–41. In the recently issued annual report for the session 1938–39, the first of Lord Harlech's chairmanship of the Governing Body, it is recorded that, in response to an appeal which he, as Mr. Ormsby-Gore, when Secretary of State for the Colonies, had put forward, the Colonial Office has promised a sum of £4,380 per annum in subvention of the work of the School, while a grant of £2,500 has been made by the University Court for the remainder of the quinquennium for the establishment of five posts—one lectureship in Japanese, one in Turkish, and three in Arabic dialects, while a later grant of £500 for a period of not less than three years was made for a lecturership in Sinhalese. The number of students, though representing a slight decrease, was still more than four hundred. While the numbers from Great Britain and the Empire showed a decrease, there was a considerable addition to those from Germany and the United States.

In the course of the report, reference is made to the valuable assistance towards African studies given by grants from the Rockefeller Foundation which during the last seven years have amounted in sums allocated to public bodies and to individuals to a total of £18,000. It will be remembered that it was through the assistance of a grant from this source, spread over five years, that the International Institute of African Languages and Cultures was enabled to plan and carry out its valuable scheme of organized African research in the field, of which the benefit is now becoming apparent not only in the monographs in course of publication but also in the projects for further research which directly or indirectly have sprung from that scheme.

Dr. Jean Paul Marat

In a recent paper (*Hippocrate*, **7**, 379; 1939) Dr. Henri Candiani protests against the unjust and cruel treatment which Marat has received not only from scurrilous pamphleteers but also from reputable historians such as Michelet, Taine and Carlyle. While not attempting to refute all the legends and calumnies concerning the "Friend of the People", Dr. Candiani confines himself to the scientific and medical aspects of his hero. So far from being a charlatan or merely a horse-leech, as Carlyle called him, he was a properly qualified medical man of St. Andrews who, during his residence in London, had a good practice in Soho when that district was a fashionable quarter. His "Essay on Man" (1775), more than half of which is devoted to anatomy, is a philosophical and psychological work, in which he has been recognized as the precursor of Cabanis, Broussais and Gall. In his "Essay on Gleets", published the same year, he criticized certain errors of treatment current at the time, including the use of hard and irritating bougies, for which he substituted softer instruments. In 1776 he made an important contribution to ophthalmology in his "Enquiry into a Singular Disease of the Eyes", in which, as Prof. Truc of Montpellier has shown, he gave a description of astigmatism which preceded the classical account of Thomas Young by more than twenty years. But it was as a pioneer in electrotherapy, on which he wrote in 1782 and 1783, that Marat chiefly deserves mention in the history of medicine. According to Dr. W. G. Turrell of Oxford, his work on this subject was on far more scientific lines than the writings of any of his predecessors or even than the publications of many of his successors. In conclusion, Dr. Candiani describes Marat as a conscientious experimenter, resolutely hostile to absurd theories or hasty generalizations.

Food of Game Ducks

Various causes have contributed to reduce, to a serious extent in some cases, the numbers of game ducks in the United States and Canada, and the interest of the public and the self-interest of the multitude of shooters alike demand that measures should be taken for the encouragement and multiplication of the duck population. The U.S. Department of Agriculture has responded to the demand by the publication of a pamphlet (Washington, D.C.: *Tech. Bull.* No. 634; 1939) of 156 pages and 153 plates, with the aim of spreading dependable information on which programmes for the improvement of breeding and feeding grounds may be based. To minimize waste of funds and loss of effort through the introduction of unsuitable foods, it is essential that the important plant and animal foods of the various species be known and that consideration be given to the range of particular species and environmental and other limiting factors. By making use of data accumulated through many years by the Biological Survey, the authors, A. C. Martin and F. M. Uhler, have presented a thorough-going treatise which from three aspects gives a lead to duck conservation and propagation. The first section presents a census of foods, based upon analyses of nearly 8,000 stomachs or gullets of eighteen species of game ducks, and indicates the regions in the United States where each food is preferred. The second part, by means of photographs and concise descriptions, is designed to facilitate recognition of these foods; and the third part contains practical suggestions on the propagation of the food of waterfowl and the development of feeding grounds.

Fauna of the Marquesas Islands

Isolated in the central Pacific Ocean, farther from the continents than any others, with one exception, themselves the relics of volcanoes perhaps of Pliocene age, the Marquesas Islands afford a perfect setting for the study of an oceanic island fauna. The study has been carried out with thoroughness by A. M. Adamson, who spent fifteen months collecting on the Islands and has made a survey of the literature bearing on the problem (*Bull. Bernice P. Bishop Museum, Honolulu*, **159**, 93; 1939). Marquesan animals are related to those of the island groups lying to the west and south-west, Samoa, Society, Cook, etc., but they show little affinity to the fauna of Hawaii. The

faunal drift has been ultimately from the Indo-Malayan region, with a sprinkling of Australian forms, but whether the Islands were populated by oceanic dispersal or by way of hypothetical land bridges seems difficult to decide, and the author gives the arguments for and against both possibilities. Whatever the origin of the fauna, it dates from not later than early Tertiary times, and as might be expected isolation has resulted in the development of a high proportion of species distinctive of the Islands, although between the isolated islands of the group, variations are pronounced only in certain families. Naturally the fauna contains a varied assortment of species, particularly mammals and birds, introduced by man, some, such as the so-called 'native' rats and pigs, probably by the early Polynesian voyagers, and all the other mammals, with the doubtful exception of dogs and mice on some of the Islands, by white adventurers.

European Rural Life

A PUBLICATION of much interest has been produced by the International Institute of Agriculture in Rome. It is entitled "Documentation for the European Conference on Rural Life, 1939", but in spite of its title it contains much of real value and much that has not previously been collected into one volume. Especially valuable is the long chapter on land reclamation and improvement in the different countries of Europe, including statistical information. This leads to a chapter on the improvement of crops, stocks and rural industries, where again various State efforts are discussed. In addition, there are useful summaries of land tenure systems in Europe and a full discussion of the present and potential density of agricultural populations as well as discussion on the economics of farming in different countries. The publication runs to nearly four hundred pages, and has various references to other sources of information.

Music in Mental Diseases

DR. ARTHUR H. HARRINGTON, late superintendent of the State Hospital for Mental Diseases, Howard, Rhode Island, states that in some public institutions in the United States the value of music systematically applied with a therapeutic purpose has been recognized as an aid in institutional activities (*Mental Hygiene*, **23**, 601; 1939). He has found that though technical instruction for groups of patients has only a very limited value, and does not produce sufficient return for the time and effort expended, mass and group singing of properly selected compositions under proper direction with the psychological aim always in mind, has a definite therapeutic value. Instrumental music of a subdued type seems to have a desirable psychological effect at meal-times, when it produces quiet and repose. In Dr. Harrington's experience the physical act of singing increases a number of bodily functions, stimulates respiration and heart action, gives increased oxygenation to the tissues and often has a favourable effect upon morbid mental states.

Memorandum on Influenza

THE Ministry of Health has issued a revised edition of the Memorandum on Influenza, first published in 1919 and revised in 1927 (Memo. H.M. Stationery Office. 2*d*. net). It is pointed out that since the great and fatal pandemic in 1918–19, influenza epidemics in England and Wales have shown a decided preference for the first quarter of the year. The disease is caused by a filterable virus, and the incubation period is about 48 hours. Infection is conveyed from the sick to the healthy by the secretions of the respiratory surfaces. Beyond adequate ventilation, with perhaps gargling with an antiseptic solution after close contact with infection, little can be done for personal protection. At the first feeling of illness, the patient should go to bed in a room by himself, keep warm, and seek medical treatment.

Health Problems of Industry

THE investigations carried out under the direction of the Industrial Health Research Board, Medical Research Council, during the year ended June 1939 are contained in the nineteenth annual report of the Board, recently issued (H.M. Stationery Office. 6*d*. net). These include a research on the toxicity of various volatile organic substances, now increasingly used as solvents in industry, work on mental integration with special reference to accidents and vocational fitness, and on vocational aptitudes, and researches on the physiological problems of heating and ventilation. Environmental conditions, such as lighting and vision, noise and deafness, and the effects on health produced by inhalation of dusts met with in industry, have also been investigated, and summaries of the results obtained are included in the report.

National Research Council of Japan

A RECENTLY received report of the National Research Council of Japan (**2**, No. 8) covers the period April 1938–March 1939. In addition to particulars of the serial publications issued, the report includes summarized accounts of the annual general meeting and of the various divisional and committee meetings, with notes on the thirteenth conference of the International Union of Chemistry and the Tenth International Congress of Pure and Applied Chemistry and other international meetings at which the Council was represented. Besides details of the officers, members and committees of the Council, the report includes a long obituary notice of Baron J. Sakurai by Dr. N. Matsui (see also NATURE, Aug. 5, 1939, p. 234), reviewing not only his scientific work but also his work in promoting research activity in Japan and her international cultural relations. Appendixes list serial publications received from abroad and tabulate those of the Council already issued.

Phytopherol: a Standardized Solution of Vitamin E

VITAMIN E is now being manufactured in Great Britain on a commercial scale and has been put within the reach of all by the British Drug Houses, who issue it as capsules of an oily solution containing

3 mgm. *dl*-α-tocopherol per 5 minims. The booklet issued by this firm contains a brief survey of the chemistry, physiological function, and general clinical applications of vitamin E. It is pointed out that not only may vitamin E be effective in combating sterility in the female in cases of habitual or threatened abortion, but also that types of pregnancy toxæmia and premature separation of the placenta as well as dysmenorrhœa and vulvovaginitis may also respond favourably to administration. It may be effective in male impotence and may produce descent of ectopic testes. About three pages of the booklet are devoted to a description of work on the relationship of vitamin E and the anterior pituitary, carried out in the B.D.H. Laboratories by Barrie.

Earthquake near Seattle

THE United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, states that an earthquake was experienced in the State of Washington, U.S.A., on November 13, 1939, at approximately 7h. 45m. 49s. G.C.T. Reports of the earthquake were received from the seismographic stations at Georgetown, Chicago, Fordham, Pasadena, Pittsburgh, Tucson, St. Louis, Butte, Weston, Williamstown, Sitka, College, Philadelphia and Lincoln. From these reports, the epicentre has been calculated to have been near lat. 47° 35′ N., long. 123° 15′ W., which is to the west of Bremerton and south-east of Mount Olympus. No damage has been reported. It is well known that the western side of the American continent is more liable to earthquake shocks than the eastern side, though both as regards frequency and intensity the State of California appears to have suffered more in the past than the State of Washington or any other of the neighbouring States.

The Colonial Service: Appointments and Promotions

THE following appointments and promotions in the Colonial Service have recently been announced: G. G. Cowley, agricultural officer, Kenya; C. J. Lawkins, agricultural officer, Nyasaland; M. A. G. Hanschell, agricultural superintendent, British Guiana; J. Paine, agricultural superintendent, Gold Coast; T. A. Phillips, agricultural officer, Nigeria; H. W. T. Webb, agricultural officer, Nyasaland; R. S. T. Bowden, veterinary officer, Malaya; R. A. Hamilton, assistant meteorologist, Nigeria; J. A. Reid, research student, Institute of Medical Research, Federated Malay States; D. L. Blunt, director of agriculture, Nyasaland, to be director of agriculture, Kenya; C. J. McGregor, agricultural officer, to be senior agricultural officer, Tanganyika Territory.

The Parliamentary and Scientific Committee

THE Parliamentary Science Committee has now been re-formed on a new basis and will henceforward be known as the Parliamentary and Scientific Committee. Following a meeting on November 8, it was agreed to form an emergency committee forthwith and to invite all former officers and members of the executive committee to serve on it. A meeting of this emergency committee was held at the House of Commons on Wednesday, December 6. Following the resignation of Mr. S. F. Markham as chairman in view of his forthcoming service abroad, Captain L. F. Plugge, M.P., was elected to the chairmanship. Prof. B. W. Holman and Mr. Alan E. L. Chorlton, M.P., will remain as vice-chairman and deputy-chairman respectively, while the new secretary is Mr. Christopher Powell. It was reported at the meeting that promises of support had been received from a large number of the organizations which previously supported the Parliamentary Science Committee.

Courses in Technical Optics

COURSES in technical optics, adapted for students with an initial training in physics or mathematics, are now being given as usual at the Imperial College of Science and Technology, South Kensington. The Technical Optics Section was founded in 1917 to meet the demands of the optical instrument industry and the Services for assistants with an optical training; and although a good many students have taken the course since that time, the present demand exceeds the supply. There are vacancies for a few more students who are prepared to begin work at once. The work is of a varied character, embracing many aspects of optical knowledge in its application to industry and to other sciences, and is of great national importance.

Cecil Peace Prize

A CECIL PEACE PRIZE of £100 is offered yearly for an essay on some subject connected with the maintenance of international peace, and having some bearing on the principles or work of the League of Nations. It is open to all undergraduates, without distinction of sex or nationality, of any university or university college in Great Britain or Northern Ireland, who have not attained the age of twenty-five years on the last day for submitting essays. The subject for the year 1940 is "What were the reasons for the 'failure' of the League of Nations in the years following 1930; and what steps should be taken after the present war to strengthen international authority?" The essay must be sent to the Secretary, Universities Bureau of the British Empire, 88A, Gower Street, London, W.C.1, so as to arrive on or before November 1, 1940. Further information can be obtained from the Secretary.

Institution of Electrical Engineers

THE meetings of the Institution of Electrical Engineers will be resumed in London during the second half of the current session if the present conditions continue. This applies to the ordinary meetings, informal meetings, meetings of the three technical sections and of the London Students' Section. As regards activities in the provinces, the various committees will decide in the light of local conditions whether they are able to carry out programmes of meetings, visits and functions. The first ordinary meeting of the programme for the

second half of the session will take place on January 25, at 6 p.m., when a discussion on "Fire-Fighting Equipment for Electrical Installations", based on the E.R.A. Report on this subject, will be introduced by Messrs. H. W. Swann, J. Hacking and R. A. McMahon.

Announcements

SIR ARTHUR SMITH WOODWARD, lately keeper of the Department of Geology, British Museum (Natural History), has been awarded the Hayden Memorial Geological Medal of the Academy of Natural Sciences, Philadelphia. This Medal, which is awarded every three years, has been given in recognition of Sir Arthur's notable contributions in the field of vertebrate and invertebrate palæontology. The Hayden award was founded at the Academy in 1888 as a memorial to Ferdinand Hayden, a member of the Academy's staff and director of the United States Geological Survey; former recipients of the award include Edward Drinker Cope, Thomas H. Huxley, William Berryman Scott and Andrew C. Lawson.

SIR GEORGE STAPLEDON, professor of agricultural botany in the University College of Wales, Aberystwyth, and director of the Welsh Plant Breeding Station, has been presented with the Gold Medal and certificate of honorary membership of the Royal Agricultural Society of England for distinguished services to agriculture.

THE Minister of Agriculture and Fisheries has appointed two additional members to the war-time Poultry Advisory Committee recently set up to give advice on matters affecting the interests of the poultry industry under war-time conditions. They are Captain Guy Clifford, a Lancashire poultry farmer, who is vice-president of the National Poultry Council and chairman of the Lancashire Utility Poultry Society, and Prof. T. J. Dalling, professor of animal pathology in the University of Cambridge.

MR. G. ANDREW, formerly lecturer in the Geological Department of the Fuad el Awal University, Cairo, has been appointed Government geologist in the Anglo-Egyptian Sudan.

MR. G. O. JONES has been appointed research fellow in the Department of Glass Technology in the University of Sheffield.

FOR many years it has been the practice of Emmanuel College, Cambridge, to invite suitably qualified candidates to make application for a research studentship to which the College elects in July. For the time being the governing body feels it is unable to make such an award. In certain circumstances, however, it is prepared to supplement awards of other bodies to research students who are making application, even if provisional, for admission to Emmanuel College. Applications must reach the Master, Emmanuel College, not later than June 30 in any year.

ACCORDING to a report from a correspondent, which is printed in *The Times* of December 12, the Institute of Experimental Physics of the University of Warsaw has been totally demolished. The whole installation of the Institute has been dismantled and all the instruments for scientific research have been sent into the Reich.

A LIBRARY devoted to the history of medicine has been established at the Yale University School of Medicine. Its basis will be formed by the collections of the late Dr. Harvey Cushing and of Dr. John F. Fulton, who is Stirling professor of physiology in the Yale Faculty.

ON October 17, Dr. Thomas Parren, surgeon-general of the United States Public Health Service, received the Sedgwick Medal of the American Public Health Association for distinguished service in public health, the presentation being made by Dr. William Rosenau, a former medallist.

EPILEPSY has been made a notifiable disease in California since September 19.

THE sixth Australasian Medical Congress (British Medical Association), which was to have been held in Perth next September, has been postponed indefinitely.

THE issue of the *Nederlandsch Tijdschrift Voor Geneeskunde* of November 4 contains an account of the proceedings of the autumn meeting of the Dutch Society of the History of Medicine, Mathematics and Natural Science held at Leyden on October 22.

THE October issue of the *Bulletin de l'Office International d'Hygiène Publique* contains the statistics for Palestine of the population, birth-rate, general and infant mortality, and the incidence of infectious diseases according to religious groups from 1933 until 1937.

A CLASSIFIED index of entomological contributions to the *Scottish Naturalist*, from 1871 until the end of 1938, appeared in that journal from July until November 1939. It covers a large proportion of the records of Scottish insects during the period in question and has now been issued in complete form, consisting of sixty-six pages and cover. Copies, price 2*s*., may be had from Messrs. Oliver and Boyd, Ltd., Tweeddale Court, 14 High Street, Edinburgh, 1.

THE variations in the number of marriages and births in Germany within recent years are shown by the following official figures: In 1932 the marriages numbered 517,000, in 1933 639,000, and in 1934 720,000. In 1935 there was a fall to 651,000 and in 1936 to 610,000, followed by a rise to 620,000 in 1937. There has also been a recent increase in the number of births. In 1933 they numbered 971,000, in 1934 1,119,000, in 1935 1,164,000. in 1936 1,179,000, and in 1937 1,275,000.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

IN THE PRESENT CIRCUMSTANCES, PROOFS OF "LETTERS" WILL NOT BE SUBMITTED TO CORRESPONDENTS OUTSIDE GREAT BRITAIN.

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 1016. CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

X-Ray Measurements on Wet Insulin Crystals

THE importance of water of crystallization in maintaining the regular structure of protein crystals has already been shown in the X-ray examination of wet and dry crystals of three different proteins: lactoglobulin, hæmoglobin and chymotrypsin[1]. It is now possible to add insulin to this list. Although the original photographs[2] of air-dried insulin crystals recorded no X-ray reflections with spacings smaller than 7 A., those of the wet crystals examined in their mother-liquor show reflections with spacings of 2·4 A. or less, which indicate that here there is regularity in the structure down to atomic dimensions.

The new measurements have been made on three different samples of insulin crystals. The first of these was given to us by Dr. A. N. Macbeth (Organon Laboratories), and consisted of crystals in their mother-liquor. The others were recrystallized by us at two different *p*H values, approximately 5·2 and 6·2 respectively. In these cases the mother-liquor was essentially a mixed sodium potassium phosphate buffer prepared as previously described[2]. All the crystals were similar in appearance to those obtained earlier. Their density, measured by flotation in a sodium dihydrogen phosphate solution *p*H 4·5 and in a sodium citrate buffer solution *p*H 5·7, varied between 1·276 and 1·283, lower than the values up to 1·315 found for the dry crystals. In an attempt to check the molecular weight calculation, preliminary X-ray measurements have been made on crystals immersed in both these density solutions and in dilute *M*/15 sodium dihydrogen phosphate solution.

The crystal lattice of the wet insulin crystals photographed in their mother-liquor proves to be a moderately expanded form of that found for the dry crystals. The

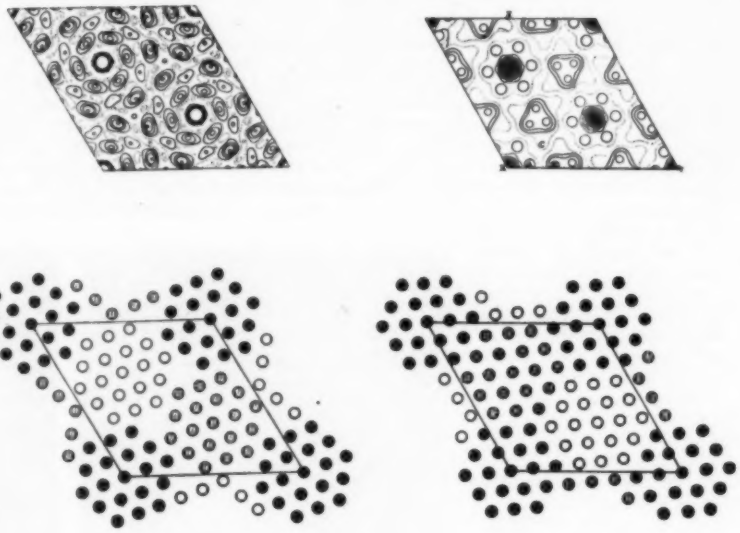


Fig. 2.

ABOVE: PATTERSON PROJECTIONS ON THE BASAL PLANE OF THE STRUCTURE OF (LEFT) WET AND (RIGHT) DRY INSULIN.

BELOW: ARRANGEMENT OF HEXAGONAL ARRAYS OF POINTS, (LEFT) EXPANDED (CF. WET INSULIN) AND (RIGHT) CLOSE-PACKED (CF. DRY INSULIN).

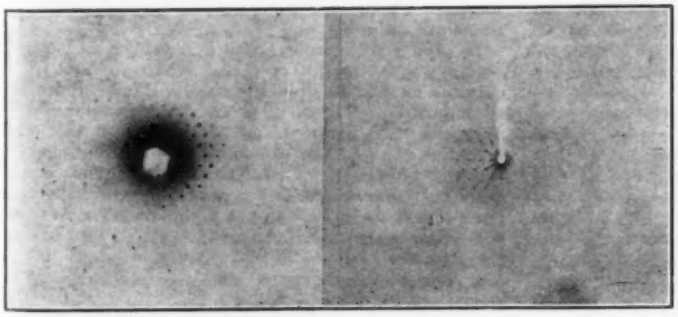


Fig. 1.

X-RAY PHOTOGRAPHS OF ZINC INSULIN SHOWING (*hiko*) REFLECTIONS. LEFT: WET CRYSTAL IN MOTHER-LIQUOR; RIGHT: ORIGINAL AIR-DRIED CRYSTAL. (SCALE NOT IDENTICAL.)

unit-cell dimensions for the hexagonal unit-cell (correct to 0·5 per cent) are: $a = 83{\cdot}0$ A., $c = 34{\cdot}0$ A., as against $a = 74{\cdot}8$ A., $c = 30{\cdot}9$ A., for the air-dried crystals, or for the rhombohedral true unit-cell, $a = 49{\cdot}4$ A., $\alpha = 114°\ 16'$, wet, and $a = 44{\cdot}4$ A., $\alpha = 114°\ 28'$, dry. Using the mean density 1·28 found above, and assuming that the molecular weight of the insulin present is 37,600 as measured on the dry crystals, it is possible to calculate the wet-cell molecular weight as 52,400, and the weight of the liquid of crystallization present as 14,800—28 per cent of the total.

How much meaning this calculation has is doubtful in view of the increasing evidence that the protein crystal lattice itself is penetrated by ions and molecules from the various immersion media. To a first approximation, the crystal structure proves to be unaltered by immersion in the citrate density solution or in the dilute phosphate solution *p*H 4·5. But X-ray photographs of crystals immersed in the phosphate density solution show both a small shrinkage of the crystal lattice, of the order of 3 per cent, and an absence of X-ray reflections with spacings less than 7 A., as in the case of the air-dried crystals. Whether this alteration is due alone to the concentration of ions in the immersion medium, or to this factor combined with the low *p*H, it is clear that here there has been a withdrawal of water from the crystal which has produced a disorganization of the structure comparable with the effect of drying.

These changes are accompanied by changes in the intensities of the X-ray reflections which should provide the means for their fuller interpretation. As is shown in Fig. 1, the X-ray intensities from the wet insulin crystals differ strikingly from those given by the dry crystals. A preliminary Patterson projection on the basal plane (0001) indicates that the differences are to be correlated mainly with a change in the relative orientation of the molecules as a whole (Fig. 2). The main interatomic distances about the origin are similar to those observed for dry insulin but are shifted through a small angle relative to the original pattern. It seems relevant to the general problem of protein structure that the new Patterson peak positions also approximate closely to one of the systems of close-packing of hexagonal aggregates postulated by Bernal[3] to account for the original peak positions. The new system is derived from that of Bernal by sliding the molecular groups relative to one another, leaving spaces to be occupied by water at definite positions in the lattice in the neighbourhood of 0, $\frac{1}{3}$; 0, $\frac{2}{3}$, etc. In agreement with this, the X-ray reflection $33\bar{6}0$ is much the most sensitive to changes in the crystal immersion medium. It is present for the dry crystals, absent for crystals photographed in their mother-liquor, and again present for crystals in the phosphate density solution, although the intensities of most other comparable X-ray reflections are here unchanged compared with the wet crystals. Such controllable variations in the X-ray intensities given by a protein crystal have been sought for some time, and here, in insulin, we ought now to be able to follow further changes produced both by alterations in the immersion medium and by replacement of the bound zinc by cadmium or nickel.

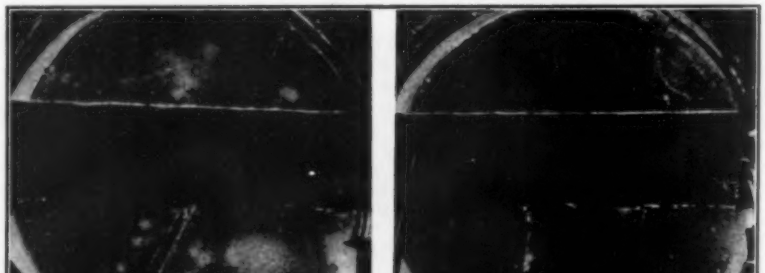
DOROTHY CROWFOOT.
DENNIS RILEY.

Department of Mineralogy,
Oxford.
Nov. 9.

[1] Crowfoot, D., Riley, D., Bernal, J. D., Fankuchen, I., and Perutz, M. NATURE, 141, 521 (1938).
[2] Crowfoot, D., *Proc. Roy. Soc.*, A, 164, 580 (1938).
[3] Bernal, J. D., *Proc. Roy. Soc.*, B, 127, 36 (1939).

Evidence for the Occurrence of Meson Pairs

WE have taken a number of photographs with a counter-controlled cloud chamber in a tunnel 30 m. under London clay. (1) 630 photographs were taken with a 1·4 cm. lead plate inside the chamber; (2) 948 photographs were taken with a 2·5 cm. lead plate inside the chamber; (3) 780 photographs were taken with a 2·5 cm. lead plate inside the chamber and 15 cm. of lead above the chamber.



a *b*

80 per cent of all the photographs show one single ray penetrating the lead plate without appreciable deviation. We consider that most of these must be mesons. 125 of the photographs show evidence of electronic showers.

In five photographs, two apparently associated particles go through the lead plate without perceptible change in direction and without producing secondaries. Three of these photographs were obtained with arrangement (1), one with (2), and one with (3). In the accompanying reproduction, *b* was obtained with arrangement (3), the angle between the tracks is 1·5° and they seem to diverge from a point 3 m. above the chamber. They have, therefore, both penetrated the 15 cm. of lead above the chamber.

A possible explanation of these photographs is that they show meson pairs.

Alternative explanations which must be considered are: (*a*) the random coincidence of independent mesons; (*b*) one or both of the particles are electronic and happen not to produce secondaries; (*c*) one or both of the particles is a proton.

It is estimated that two tracks which appear identical must be formed within 1/50 sec. of one another. The chamber is set off by the counters, on an average, once in 12 minutes, so that the probability of the random simultaneous appearance of two non-associated rays is of the order 3×10^{-5}.

An electron capable of passing through 2·5 cm. of lead without sensible deviation by ordinary scattering must have an initial energy greater than 10^9 e.v. The probability that only a single electron of high energy would emerge from the 2·5 cm. plate may be calculated from cascade theory as 0·007 for a 10^9 e.v. particle and negligibly small for one of higher energy. The particles which penetrated 15 cm. of lead could not be electronic.

J. G. Wilson[1] has calculated that the probability of a meson producing a knock-on proton of high energy is much too small to account for our photographs, and any process by which one proton knocks-on another would be expected to give rise to a number of slow protons distinguishable as heavy tracks. No such tracks have been observed.

We consider that our photographs are best regarded as evidence for meson pairs.

Birkbeck College,
London, E.C.4.
Nov. 17.

H. J. J. BRADDICK.
G. S. HENSBY.

[1] By private communication.

Occurrence of Greenockite in the Mendips

ALTHOUGH small amounts of greenockite (cadmium sulphide) have been found in Scotland associated with zinc blende, the mineral has rarely been found in England. In July last one of us (A. W. G. K.) was examining blende from a small dump at some old workings at a hamlet called Green Ore near Chewton Mendip. The area was at one time worked for calamine (zinc carbonate) and most of the material of the dump consisted of this; but blende, galena and barytes were also present.

Thin layers of a yellow mineral, ranging up to about 1 mm. in thickness, were noticed in various small patches in the blende. These were afterwards examined spectroscopically and chemically and proved to be greenockite. There appears to be no record of the mineral having been observed in the Mendips before this.

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Cumberland Lodge,
Bathwick Hill,
Bath.

J. NEWTON FRIEND.
Central Technical College,
Birmingham.
Nov. 15.

A New British Locality for Fluorite in Somerset

ALTHOUGH small amounts of fluorite were recorded many years ago from the Avonian Limestone of the Avon Gorge at Clifton, it does not appear to have been found there again, or to have been previously recorded from any part of the Carboniferous of the adjoining Mendip Hills.

In November last year, I found minute traces of a dark purple granular mineral in a disused quarry in Shipham Gorge, near Axbridge on the south side of the Mendips. Subsequent tests showed this to be fluorite, but the amount was too small for satisfactory examination.

This year, however, further search has resulted in the collection of a number of small but well-formed crystals. These crystals range in colour from colourless to almost black, purple and mauve shades being the only ones so far noticed: they are all small, the largest being about 3 mm. across the cube face. The sample cube, a {100}, and the low 4-faced cube, *f* {310}, are the most frequent forms, but combinations of these two also occur. Some crystals recently found are very complex; many crystals are well zoned and in some specimens the fluorite crystals are accompanied by beautiful little bright crystals of chalcopyrite and little velvety black hemispheres of hæmatite.

The fluorite appears to be confined more or less to one band in the quarry and occurs in granular calcite filling vesicles in the black limestone of the *C*-zone. These vesicles are numerous, but the majority appear to contain no trace of fluorite.

Careful search in this and other parts of the Mendips over a number of years has failed to produce any other specimens, and so far this appears to be the only locality in the district.

ARTHUR W. G. KINGSBURY.
Cumberland Lodge,
Bathwick Hill,
Bath. Nov. 15.

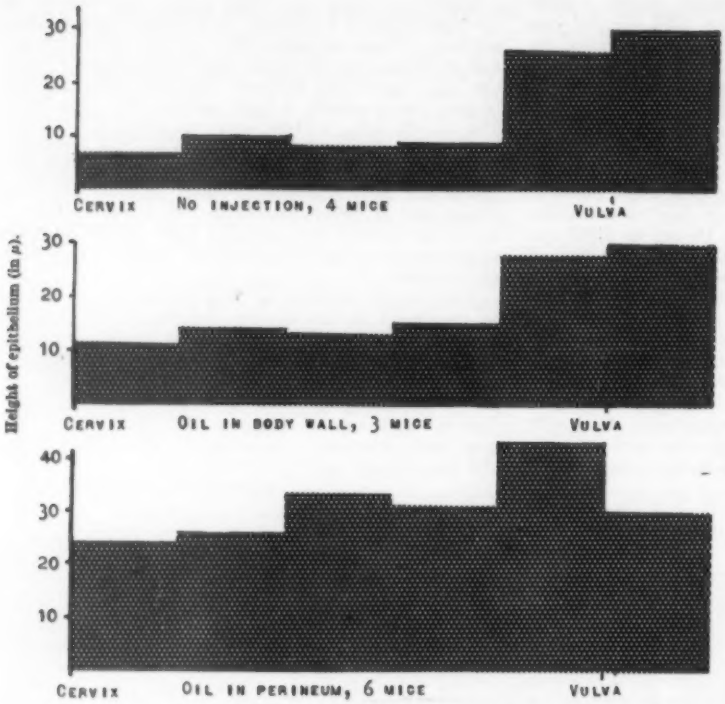
Œstrogen Depot Formation

IN a recent communication, Zondek and Sulman[1] showed that, unlike œstrone, the hormone esters and stilbœstrol in oil, when injected into the rat, remain at the site of injection for a considerable time and from there are slowly absorbed.

Some time ago I undertook an investigation into the local effect upon the vaginal epithelium of the ovariectomized mouse of small doses of œstrone in arachis oil. The preliminary results showed little of interest, and the inquiry was put aside under pressure of other work. At the time I noticed, however, that a few control mice which received small doses of arachis oil alone, and showed little or no effect when the dose was injected into the body wall, did show proliferation of the vaginal epithelium, resembling that preceding œstrus, when the dose was injected into the perineum. The results are shown in the accompanying diagram. With doses of oil of from 0·0025 c.c. to 0·005 c.c. after times between 24 and 48 hours, the height of the epithelium is increased. This increase is a good deal more noticeable when the dose is administered in the perineum than when it is injected into the body wall.

From this it appears that (1) arachis oil, or some part of it, has the property of initiating some proliferation of the epithelium lining the vagina of the ovariectomized mouse; (2) this effect is rather localized.

The localization of the effect of the oil may in all probability be taken to indicate that the oil, or some fraction of it, forms a depot at the site of injection and is not distributed immediately all over the body. If this is so, then it may be that the depot-forming qualities of the solvent have some bearing upon the depot-forming qualities of the œstrogenic injection as a whole. The depot-forming qualities of arachis oil appear to have been made plain in these experiments through the accident of its effect upon this epithelium, which can be measured. It may be that some œstrogens, for example the esters mentioned and also stilbœstrol, simply tend to remain dissolved



The height of the epithelium was measured first at the cervix and then once on each side of a longitudinal vertical section every 100 μ until the vulva was reached. The two measurements, one on each side of the section, were then averaged. The length of the vagina was then divided into five equal parts. The average was then found of those previously found averages which fell within each of these five segments. The resulting quantities are the ordinates in the histogram. The first five 'cells', counting from the left, represent the five equal segments of the vagina. On the right is added an extra 'cell', 30 μ in height, which represents the height of the epithelium on the surface of the body.

in the solvent in which they were injected in preference to passing into the body fluids. This may be perfectly explicable in terms of chemistry and physics. It may be incorrect to assume that the œstrogen itself enters into any particularly close relationship with the tissue at the site of injection regardless of what that tissue may be.

I am about to publish in the *Proceedings of the Zoological Society* some observations which seem to show that a particular sub-system within an animal —for example, a feather-germ—which uses or is affected by œstrone, may really have in itself the power of stocking up with the hormone. It presumably accomplishes this in the time available between the giving of the dose and its removal or destruction. Zondek[2] has shown that for this substance, œstrone, this time may be very short—a matter of hours. The stock laid in may be changed (it has not been recovered to see whether its œstrogenic properties remain unaltered), but it lasts for days, or at least its very strictly localized effects do.

In view of the obvious importance of an understanding of depot-formation to the whole subject of hormonic physiology and the action of carcinogens and evocators, it seems that further information is required about (*a*) the possibly pseudo-œstrogenic qualities of arachis oil, in order that the experimenter may be clear about all the œstrogens actually present in the injection, and (*b*) the precise circumstances in which the known œstrogens, and so perhaps other active substances, do pile up at points in experimental material or in Nature. It is hoped to continue these investigations in this Department.

PAUL G. 'ESPINASSE.
Department of Zoology,
University College,
Hull.
Nov. 7.

[1] Zondek and Sulman, NATURE, 144, 596 (1939).
[2] Zondek, *Lancet*, 227, 356 (1938.)

Connexion between Carbohydrate and Potassium Metabolism in Normal and Adrenalectomized Animals

OF the different metabolic disturbances caused by adrenalectomy, the increase of potassium in the blood plasma is believed by some authorities to be the most important, while others have emphasized more especially the disturbances in carbohydrate metabolism. It now seems possible, however, to connect these two sets of metabolic disturbance, as has been suggested earlier[1] and can now be proved.

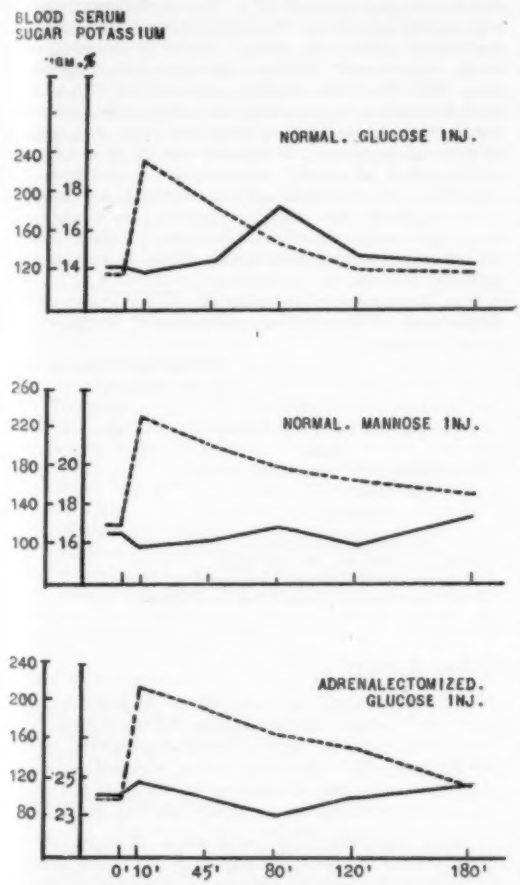
After intravenous injection of glucose (5 c.c. of 20 per cent solution in 1 minute to a cat of 2–3 kgm.), the blood sugar rises to about twice its normal level and returns to normal after two hours. The same is true for galactose and fructose. Other hexoses, such as sorbose and mannose, and the pentose xylose, behave quite differently: the sugar in these cases leaves the blood much more slowly, and after two hours the blood sugar is still 50 per cent higher than normal. Thus the different sugars behave in the same way in the transit between the blood and the tissues as between the lumen of the intestine and the epithelial cells during intestinal absorption. Those sugars which are selectively absorbed are also more rapidly taken up from the blood by the tissues than are the non-selectively absorbed sugars.

After adrenalectomy, the changes in the behaviour of the different sugars in the blood are parallel to the changes in sugar absorption. Intravenously injected glucose, galactose and fructose are now taken up by the tissues just as slowly as the other sugars whose rate of leaving the blood has not been changed by adrenalectomy. Just as the specific process in the intestinal epithelium necessary for the selective absorption of glucose, galactose and fructose is lacking after adrenalectomy, so also is the specific process by which these three sugars leave the blood more rapidly than other sugars abolished.

It was then shown that injections of glucose, galactose or fructose caused a sudden increase of

blood potassium, while injections of other sugars caused no increase. With the selectively absorbed sugars, the peak of the potassium curve is reached only when the sugar concentration in the plasma has already begun markedly to decrease.

In adrenalectomized animals, however, there is no increase in plasma potassium after intravenous injection of the selectively absorbed sugars. These sugars now react in the same way as the non-selectively absorbed sugars. The conclusion must be



DOTTED LINE, BLOOD SUGAR; FULL LINE, SERUM POTASSIUM. AT 0' 0·50 GM./KGM. SUGAR WAS INJECTED INTRAVENOUSLY.

that there is a close connexion between the rapid uptake by the cells of the selectively absorbed sugars and the increase in plasma potassium. It seems most probable that the process which connects these two phenomena is a phosphorylation process leading to the formation of glycogen or intermediary substances. The possibility of such a mechanism has recently been stated by Conway and Boyle[3]. It would then follow that it is this process which is lacking after adrenalectomy, thus causing the disturbances both in carbohydrate and in potassium metabolism seen in adrenalectomized animals.

The figures are examples of experiments which will be published in *Helvetica medica Acta*.

F. VERZÁR.
Physiological Laboratory, J. C. SOMOGYI.
University, Basle.
Nov. 1.

[1] Verzár, F., Sixteenth Int. Physiol. Congr. 1938, and "Funktion der Nebennierenrinde", B. Schwabe (Basel, 1939).
[3] Conway, E. J., and Boyle, P. J., NATURE, 144, 709 (1939).

Anserine in Muscle: Possibility of Determination by Titration

SOME time ago[1], I showed that the buffering power of the non-protein constituents of rigor muscle between *p*H 6 and 7 could be largely accounted for by the sum of the buffering powers of the phosphate, carnosine, and lactic acid present. In the muscles of some animals, notably the horse, ox, and pig, these constituents accounted for more than 90 per cent of the non-protein buffering; in others, notably the rabbit, dog and fowl, a considerable residue of buffering—up to 26 per cent of the non-protein buffering of the muscle—remained unaccounted for. I suggested that this buffering might be largely due to anserine, which has a buffering range almost identical with that of carnosine, but reliable analytical data for anserine were not then available.

Zapp and Wilson[2] have, in the meantime, published a method of determining anserine, and give values for the anserine content of the muscles of various species which are of such a magnitude as to account completely for this unidentified buffering. Some instances are included in the accompanying table.

Species	Anserine equivalent of unidentified buffering (mgm./100 gm.)	Anserine reported by Zapp and Wilson (mgm./100 gm.)
Horse ..	50	17–48
Ox	110–240	38–144
Rabbit ..	325–495	223–502
Rat	160–310	319
Dog ..	270	212

The coincidence in the magnitude of anserine contents is extremely close, and although individual muscles vary widely the conclusion is justified that the unidentified buffering does represent buffering due almost exclusively to anserine.

The determination of residual buffering (that is, after deducting that due to phosphate, carnosine and lactic acid) may, therefore, serve as a rough guide to the amount of anserine present in muscle; it will certainly serve as a true guide to the upper limit of this substance present, for the actual titration of the muscle extract is accurate, the determination of phosphate is accurate, and the determinations of lactic acid and carnosine are reasonably so. The whole determination can be carried out on the extract from 10 gm. of muscle in a few hours (as compared with the several days needed for Zapp and Wilson's method) and many samples could be examined together.

It is proposed, when the opportunity offers, to evaluate the possibilities of the method by carrying out parallel analysis by Zapp and Wilson's method and by the titration method.

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Nov. 15.

[1] *J. Physiol.*, **92**, 336 (1938).
[2] Zapp and Wilson, *J. Biol. Chem.*, **126**, 9, 19 (1938).

Isolation of a Catalytically Active Flavoprotein from Liver

WE have obtained from pig liver a flavoprotein in highly purified form which catalyses specifically the oxidation of aldehydes to their corresponding acids. The prosthetic group of this enzyme is flavinadenine dinucleotide. In the presence of acetaldehyde the enzyme is rapidly reduced to its leuco form, and the leuco form is autoxidizable in air. The mechanism of the catalysis, therefore, involves a cycle of reduction of the flavoprotein by the substrate followed by oxidation of the leuco form by molecular oxygen or any other suitable hydrogen acceptor. One molecule of the enzyme catalyses the oxidation of about 550 molecules of acetaldehyde per minute at 38°. Our best preparations of the enzyme transfer 2700 μl.H_2 per mgm. protein per hour ($Q_{\text{methylene blue}}$ 2700). The flavinphosphate content of the preparation as determined by direct estimation is 0·17 per cent. There appears to be some coloured grouping other than flavin which is associated with the enzyme molecule.

The above enzyme is not identical with xanthine-aldehyde oxidase either of milk or liver.

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D. E. GREEN.
A. H. GORDON.

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Nov. 22.

Synthesis of Myristicin

ALTHOUGH it is now many years since myristicin was first isolated from the oils of nutmeg and mace, its synthesis has not previously been recorded. Its constitution was established by H. Thoms in 1903[1] as 3-methoxy-4 : 5-methylenedioxy-1-allylbenzene, a molecule suitably orientated for its use as the starting point in the successful syntheses of cotarnine by Salway[2] and by Becker and Decker[3].

Allylation of pyrogallol 1-methyl ether gave, in good yield, a mixture of two liquid monoallyl ethers (I and II) which were separated by fractional distillation and characterized by the preparation of their 3 : 5-dinitrobenzoates (m.p. 111/2° and 134° respectively). I (most probably 1-hydroxy-2-allyloxy-3-methoxy-benzene) readily rearranged on pyrolysis to give 3-methoxy-4 : 5-dihydroxy-1-allylbenzene, and this on methylenation with methylene iodide and anhydrous potassium carbonate in acetone (Perkin and Trikojus[4]) gave a 30 per cent yield of pure myristicin (b.p.$_{0\cdot1}$ = 95–7°). The synthetic product was characterized by the preparation of dibromo-myristicin dibromide (m.p. 127–8°), *iso*-myristicin (m.p. 43·5°) and dibromo-*iso*-myristicin dibromide (m.p. 158·5°). The melting points of all three compounds were not depressed by admixture with the corresponding derivatives prepared from a specimen of natural myristicin isolated from oil of nutmeg.

The other monoallyl ether (II) did not give the expected 2 : 3-dihydroxy-4-methoxy-1-allylbenzene after pyrolysis, but a mixture which, on methylenation and subsequent bromination, yielded mainly dibromo-myristicin dibromide. This rearrangement is being further investigated.

Our thanks are due to Dr. T. G. H. Jones, of the University of Queensland, who kindly supplied the oil of nutmeg.

VICTOR M. TRIKOJUS.
D. E. WHITE.

Department of Medicine
and
St. Andrew's College Laboratory,
University of Sydney.
Nov. 10.

[1] Thoms, H., *Ber.*, **36**, 3446 (1903).
[2] Salway, *J. Chem. Soc.*, **97**, 1208 (1910).
[3] Decker and Becker, *Annalen*, **395**, 328 (1913).
[4] Perkin and Trikojus, *J. Chem. Soc.*, 1663 (1927).

Points from Foregoing Letters

X-RAY photographs of zinc insulin crystals in several immersion media have been obtained by D. Crowfoot and D. Riley. The wet crystal unit cell is found to be a moderately expanded version of that previously found for the air-dried crystals. Preliminary calculations show that the striking differences in the X-ray intensities given by the different crystal structures is to be correlated mainly with a reorientation of the molecules relative to the crystal axes which takes place on drying.

A number of cloud chamber photographs of cosmic ray particles have been taken by H. J. J. Braddick and G. S. Hensby under 30 m. of London clay. Most of the photographs show mesons, some show electronic showers. In five photographs out of 2,300 there is evidence of the simultaneous passage of two penetrating particles, and these are interpretated as associated mesons.

A. W. G. Kingsbury and J. Newton Friend report that the rare mineral greenockite (cadmium sulphide), seldom found in England, has been discovered in small quantity as thin layers in blende near Chewton Mendip. A. W. G. Kingsbury also describes a new locality for small quantities of fluorite in a disused quarry near Axbridge.

Paul G. 'Espinasse reports a possibly pseudo-œstrogenic effect, which appears to be localized, of arachis oil upon the vaginal epithelium of the mouse. He suggests that the local action of some œstrogens may be due to their remaining in the oil at the site of injection in preference to going into the body fluids.

After adrenalectomy, rats show changes in the behaviour of the different sugars in the blood (parallel to changes in sugar absorption) and also disturbances in potassium metabolism. F. Verzàr and J. C. Somogyi present observations suggesting that the connexion between these two phenomena is due to a phosphorylation process leading to the formation of glycogen or intermediary substances.

E. C. Bate Smith describes a possible titration method for the determination of anserine in muscle. The determination can be carried out in a few hours as compared with the several days needed for Zapp and Wilson's method.

A new flavoprotein has been obtained from pig liver by V. Subrahmanyan, D. E. Green and A. H. Gordon, which has the property of catalysing the oxidation of aldehydes to their corresponding acids. It has been found to contain flavinadenine dinucleotide.

RESEARCH ITEMS

Bacteria of the Throat and Nose

AN account of the micro-organisms, the normal bacterial flora, found in the nose and throat of persons living in London and south-east England, some of whom were repeatedly examined over a period of seven years, is given in a report by Drs. Edith Straker, Bradford Hill and R. Lovell, published by the Ministry of Health (Reps. on Pub. Health and Med. Subjects, No. 90. H.M. Stationery Office. 2s. net). The inquiry, which lasted from 1930 until 1937, included repeated swabbings of volunteers from among the staff of the London School of Hygiene and Tropical Medicine, and of boarders in a boys' public school. Swabbings were also occasionally taken from inmates of the Royal Hospital School, Greenwich, of an orphan home, and from members of the clerical staff of the Ministry. The work shows that of any large group of adults living in an urban community between 20 and 40 per cent will usually at any one time be carrying a pneumococcus in the nasopharynx, between 5 and 15 per cent a hæmolytic streptococcus, between 40 and 80 per cent the so-called influenza bacillus, and between 5 and 20 per cent the meningococcus of cerebro-spinal fever. The pneumococcus and the meningococcus were less frequent in women than in men. The pneumococcus was found more frequently in cold damp weather than during hot dry periods, while the reverse association tends to occur with the hæmolytic streptococcus. The last-named organism shows a sharp rise in prevalence in boys' boarding schools in association with outbreaks of tonsillitis. Neither the pneumococcus nor the influenza bacillus shows any close association with the fluctuations in mortality attributed to influenza. Observations made on persons suffering from colds tell strongly against the view that the acute infectious cold is caused by any of the bacteria studied. Dr. Rosher contributes a section on the frequency of the influenza bacillus in the trachea of unselected cases without respiratory disease coming to post-mortem examination; this organism was found in 27 per cent of such cases.

Markings on Fossil Bones

ONE of the side-lines of investigation which invariably leads to interesting and sometimes to important indications of the make-up of a prehistoric fauna is the study of the markings upon bones. Bones may be fractured or marked by contemporary human beings, by animals and by various kinds of weathering and chemical action; and as a rule careful scrutiny reveals not only the agency, but in the case of animal markings perhaps even the species concerned. Not much attempt has been made to systematize the distinctive characters of markings as a guide to other workers, but in an excellent paper, copiously illustrated, Pei Wen-Chung discusses his experience with bones from a series of sites in China ranging from Pliocene to historic times ("Le rôle des animaux et des causes naturelles dans la cassure des os", *Palæont. Sinica*. N.S., D., No. 7, 1938). He describes the characteristic appearance of markings caused by the gnawing of rodents of different kinds and by carnivores, the striations due to the scratchings of carnivore claws, vermiculations which are sometimes puzzling, and the indications of chemical action or the effect of water. Not the least useful section of his paper deals with examples of markings which, although due to other agents, might well be mistaken for human artefacts. Such errors of interpretation may easily be made by workers not familiar with the variety of markings which may be made by animal or physical agency.

Barnacle Communities

F. HIRO, in a survey on the barnacle communities at the Madarai Pier in Korôru Island, Palao (Palao Tropical Biol. Stat. Stud., No. 4), deals with the distribution and orientation of four species of Tetraclita and one of Chthamalus on vertical concrete piers. The various species show a clearly marked vertical zonation, Chthamalus occupying the highest zone, and extending to high-water mark. Where channels are cut under the pier, the Chthamalus show a marked tendency to avoid the parts where light and currents are strongest, while the Tetraclita species do not show this effect. Finally, in the centre of these cuts where light is weak, most barnacles are orientated at right angles to the current so that they can, by twisting the body through 90°, feed readily in a current coming from either direction, while those near the ends of the cuts tend to be orientated towards the light.

Bacterial Synthesis of an Eye Colour

THE diffusible substances v^+ and cn^+, which are essential for pigment formation in eyes of Drosophila individuals dominant for these genes, can be formed by recessive *vbw* insects cultured on starvation diet. E. L. Tatum (*Proc. Nat. Acad. Sci.*, 25, 486–497; 1939) now also finds that under suitable conditions certain bacteria synthesize a substance which has the activity of v^+. All the present evidence indicates that the product from bacteria is identical with v^+. An unidentified Bacillus species in the presence of tryptophane, can produce this substance, which is soluble in water and ethyl alcohol but insoluble in acetone and chloroform. Like v^+, this substance is transformed into Cn^+ when introduced into *vbw* flies.

Polyploidy in the Salamander

G. FANKHAUSER (*J. Hered.*, 30, 377–388; 1939) finds that the somatic chromosome number of *Eurycea bislineata* is 28. Of 134 larvæ examined, 13 were triploid with 42 chromosomes and 2 were tetraploid. The larger cells and pigment pattern allow the polyp oid larvæ to be tentatively identified. The tetraploids were weaker and retarded in growth. Among 311 individuals of Triturus five were found to be triploid.

Fluorination of Phosphorus Halides

THE fluorination of phosphoryl trichloride and phosphorus tribromide has been studied by H. S. Booth, S. G. Frary, and F. B. Dutton (*J. Amer. Chem. Soc.*, 61, 2934, 2937; 1939). The phosphorus compounds were treated with antimony trifluoride, with bromine or antimony pentachloride as catalysts, or in the case of phosphorus tribromide with dry

calcium fluoride. In this way the new compounds dibromomonofluorophosphine $PFBr_2$ and monobromodifluorophosphine PF_2Br were obtained from phosphorus tribromide. $PFBr_2$ is a colourless liquid (b.p. 78·4°, f.p. −115·0°), PF_2Br a gas (b.p. −16·1°, f.p. −135·8°), both hydrolysed by atmospheric moisture, decomposing slowly into PF_3 and PBr_3 at −78°, reacting with mercury with liberation of phosphorus, and combining with bromine to form, probably, $PFBr_4$ and PF_3Br_2. From the fluorination of phosphoryl trichloride by the same methods, gaseous PF_3 (b.p. −39·8°) and phosphoryl difluoromonochloride POF_2Cl (b.p. 3·1°, f.p. −96·4°), and liquid phosphoryl monofluorodichloride $PFCl_2$ (b.p. 52·9°, f.p. −80·1°) were obtained. All these substances are colourless and do not attack glass when dry.

Mercuric Halide Complex Ions

WHEN $HgCl_2$, $HgBr_2$ and HgI_2 are dissolved in solutions of the corresponding alkali metal halides, it is known that complex anions are formed. These have been represented as $HgCl_3'$, $HgBr_3'$, HgI_3', whilst evidence has been submitted for the existence of $HgBr_4''$ and HgI_4''. A. B. Garrett (*J. Amer. Chem. Soc.*, 61, 2744; 1939) has determined the solubilities of mercuric bromide and iodide in the corresponding potassium halide solutions. The solubility of mercuric bromide in pure water at 25° was found to be 0·0170 mol./1000 gm. water. The solubilities of mercuric bromide can be accounted for on the assumption that the only complex ion formed is $HgBr_3'$. In the case of mercuric iodide, however, an additional reaction is probably present, namely the formation of HgI_4'' in appreciable amount. The amount of $HgCl_4''$ is negligible; but the solubility of mercuric chloride in low concentrations of chloride solutions is anomalous. This is accounted for on the basis of polymerization of mercuric chloride to the order of 10 per cent. The free energies of formation of the complex ions from mercury halide and halide ions are given in gm. cal. at 25° as: $HgCl_3'$ −1700; $HgBr_3'$ −365; HgI_3' +430; HgI_4'' −2100.

Structure of Potassium Molybdocyanide Dihydrate

The substance potassium molybdocyanide dihydrate $K_4Mo(CN)_8.2H_2O$, is one of the more familiar examples of compounds containing eight atoms or radicals bound to a central atom. The configuration of the MX_8 group has not previously been established with certainty in any single case, although the cube and the square Archimedean antiprism have been regarded as geometrically plausible. J. L. Hoard and H. H. Nordsieck (*J. Amer. Chem. Soc.*, 61, 2853; 1939) have shown by X-rays that the $Mo(CN)_8$ polyhedron is a duodecahedron with eight vertices and triangular faces. It can be described as the figure outlined by the vertices of two interpenetrating bisphenoids orientated in the same way as the positive and negative tetrahedra of a cube. Although required by the space group to possess only a plane of symmetry, the complex ion in the crystal approximates to the symmetry of one of the point groups.

Raman Spectrum of Gaseous Methylamine

THE literature on Raman effect contains very few researches on gases or vapours because of the difficulty of procuring good spectra at comparatively low pressures and with relatively short exposures. It is, therefore, extremely interesting to find that a new technique has been developed by Kirby-Smith and Bonner (*J. Chem. Phys.*, 7, 880; 1939) which, by using a light source of high intensity, a large scattering volume, and a spectrograph camera with a large aperture, gives satisfactory spectra of gases at a pressure of approximately three atmospheres after an exposure of from three to six hours. Data for gaseous methylamine are given and compared with those of Kohlrausch (*Monatsh. Chemie*, 68, 349; 1936) for the liquid. The most noticeable difference between the spectra is in the position of the N-H valency vibrations near 3400 cm.$^{-1}$; in the liquid they are at 3312 and 3372 cm.$^{-1}$, whereas the gas shows them at 3360 and 3470 cm.$^{-1}$. These large differences are attributed to the formation of hydrogen bonds between neighbouring NH_2 groups in the liquid. For C-H vibrations, on the other hand, the largest difference between gas and liquid is 12 cm.$^{-1}$. Whereas all methyl compounds should possess only two vibrations characteristic of C-H bond stretching, methyl halides exhibit three, and gaseous methylamine is found to have four. Their origin is given as a double Fermi resonance (*Z. Physik.*, 71, 250; 1931) between a fundamental near 2840 cm.$^{-1}$ and two infra-red bands at 1460 and 1426 cm.$^{-1}$. The appearance in gaseous methylamine of a hitherto unrecorded displacement of 781 cm.$^{-1}$ is explained as due to an N-H bending vibration, on the grounds that such a vibration in the liquid would be sensitive to hydrogen bonding and association.

Determination of Stellar Diameters by Interferometer

A PAPER was formerly published (*Mon. Not. Roy. Astro. Soc.*, 99, 141) by Fürth, Sitte and Appel, which proposed a modification of Michelson's stellar interferometer that would enable it to be used even when there were strong air perturbations. Two independent papers have now appeared (*Mon. Not. Roy. Astro. Soc.*, 99, 9; October 1939) by P. Lacroute and J. A. Carroll, both of which criticize the efficiency of the apparatus. Lacroute shows that in the modified form suggested, even if fixed fringes are formed, that is, fringes insensible to movements of the Michelson fringes, they would be utterly useless for the determination of stellar diameters. He shows, however, that they are not insensible to movements of the Michelson fringes, and offers a tentative explanation of the reason why the authors of the original paper thought they observed stability, though he admits that the explanation may be conjecture, because some of the experimental details could easily be missed by anyone reading the description. Carroll shows that they drew an incomplete analogy between a ruled grating illuminated by plane waves and the Michelson fringe system, because the displacement of the Michelson fringes, in the focal plane of the observing telescope, does not correspond to a simple translatory motion of a grating, but to a translation and also a rotation, about an axis parallel to the rulings, of the incident light. For this reason the secondary system must move through the same number of fringes as the primary Michelson system. He also tested the secondary fringes to see if they were less liable to disturbances than the Michelson fringes, and found that the claim could not be substantiated. It appears from the criticism of Lacroute and Carroll that the apparatus for the elimination of strong air perturbation effects is of no use for that purpose.

THE EVOLUTION OF THE STARS

By F. HOYLE AND R. A. LYTTLETON,

ST. JOHN'S COLLEGE, CAMBRIDGE

PROF. G. GAMOW has recently discussed in NATURE[1] the consequences of recent developments in nuclear theory on the problem of stellar evolution. In the light of the exact knowledge that is now available of a large number of nuclear reactions, it is possible to decide which processes rise to importance at the densities and temperatures prevailing in the stars, and on this basis trustworthy estimates have been given for the rate of liberation of subatomic energy. These results, which are the outcome of laboratory investigations, furnish the mathematical theory of internal constitution of the stars with a new equation that enables the luminosity of a star to be calculated by direct methods. The information so obtained has been utilized to attempt to resolve the many paradoxes and discrepancies encountered in discussing the general problem of stellar evolution. All this recent work has been authoritatively summarized by Gamow with great clarity and understanding in the article referred to above. It is therefore with some surprise that we find that Prof. Gamow concludes his article with the impression that these new developments practically solve the problems of stellar evolution. This seems to us to be so far from being the case that some further discussion of the claims of nuclear theory as the main factor in stellar evolution would be desirable.

In the first place, it should be noticed that the application of nuclear theory in its present state inevitably leads to a result at least as embarrassing as any of the questions that it might possibly resolve. For the theory maintains that no synthesis of atomic nuclei from hydrogen is possible within the stars except for the very light elements. This would imply that the stars can no longer be regarded as the building place of the heavy elements, which must have formed before they became part of the star—if indeed they ever were formed. Now although such a conclusion does not itself constitute a logical contradiction, it seems to us to present such overwhelming difficulty that it is much more reasonable to conclude that the basis of nuclear theory is in need of revision rather than that the heavy elements were not formed by synthesis. On the other hand, many investigators seem to have accepted the former result as satisfactory, and in particular Gamow has proceeded to make it the basis of a theory of the red giant stars.

Secondly, Prof. Gamow apparently regards the conclusion that various classes of stars should be of totally different ages as a natural one. Thus the fact that the present theory leads to a life-time for certain massive stars of order 10^{-3} the life-time of the sun is not regarded as a difficulty at all; indeed it is merely supposed that this is the case and the theory remains unquestioned. In point of fact, it is an essential part of the theory as proposed by Gamow that all red giant stars are considered as of very recent formation, since the presence of lithium, etc., is required to enable them to radiate with their supposed low internal temperatures.

Now if all the stars could be regarded as single autonomous bodies, it would be difficult to dispute the validity of these views by direct means. But it so happens that the frequent occurrence of binary systems enables a simple test of the theory to be made, for in the case of binary stars both components must be of comparable age. It is immediately clear that the well-known difficulty concerning the relative emission per unit mass of the components of double-stars must remain in any theory that appeals only to the internal properties of the stars, although by making very artificial assumptions in Gamow's theory some of these discrepancies might be avoided. For example, it would require as a general result that the less massive components of binary systems form with a hydrogen content differing systematically from that of their companions. In certain cases this would lead to even more dubious initial conditions: thus, whilst Sirius must have formed with high hydrogen content, it would have to be assumed (according to the more generally accepted theory of degenerate matter) that the companion formed almost solely from heavy elements for it to have been practically exhausted during the whole of its existence. Such a solution of this difficulty could scarcely be regarded as satisfactory even if there were no other objection to the theory described by Gamow.

It should be particularly noticed that the foregoing suggestion assumes that the components have not evolved by fission, for this latter process (even if it were dynamically satisfactory) would clearly lead to two stars of closely similar compositions. We have been able to show, however, that to produce close binary systems, periods of order 5×10^{10} years are necessary[2]. Thus the existence of spectroscopic binary systems in which one component is a red giant or any highly luminous star presents an immediate contradiction of the theory given by Gamow. Moreover, there seems to be a general tendency for the mass of binary systems to increase with decreasing separation.

While on the subject of fission, it is perhaps only proper to point out here that although the mathematical investigations of the development of rotating fluid masses clearly demonstrate that binary stars cannot be generated by fission[3], many astronomers do not yet seem to have realized the physical significance of the mathematical results. As a consequence of this there are still many who 'believe' in the fission theory. But as will be seen, even an appeal to fission could not save Gamow's theory of the red giant stars, in addition to which it would raise afresh the difficulty of the relative emissions of the components in binary stars. Even if some process of break-up of a single star led to a binary system, it is evident that the components must have similar chemical compositions, while in close binary systems consisting of a red giant star and a class *B* star, Gamow's theory would require the red star to be the less massive component on account of the mass luminosity

relation. But observation shows that in such pairs the giant star tends to be the more massive component. This is the case, for example, in the three stars v Sagittarius, VV Cephei and ζ Aurigæ. Thus it seems that no matter from what angle we approach the questions raised by the observed properties of binary systems, the paradoxes already recognized by astronomers must remain in one form or another.

However, quite apart from the foregoing objections to the constructive portion of Gamow's article, it is very noticeable that no reference is made to the wide class of dynamical features that is associated with the stars. This, of course, is the direct result of attending only to the internal physical properties of the stars; but the dynamical features we have in mind are altogether too marked to remain unaccounted for in a satisfactory theory. Thus such questions as the formation of individual stars, and of binary and multiple systems, together with the general increase of mass with decreasing separation, and the observed approximation to equipartition of energy among the stars seem to present the real key to any theory of stellar evolution. An internal theory can give no explanation for the correlation between peculiar velocity and spectral class or the observed tendency for massive stars to lie in the galactic plane, features that must be related to the previous history of the stars.

It has been customary during recent years for investigators on stellar evolution to devote attention to internal constitution with little or no regard for the dynamical features. It appears that Prof. Gamow has followed essentially in this tradition and therefore confined his article to the modifications effected by the introduction of modern nuclear theory. Thus, in dealing with the properties of variable stars, no attempt is made to account for the three distinct periodicity groups comprised by stars of periods of order half a day, four days and 300 days. These variables also show a marked preference as regards spectral class, the first being largely of classes B and A, the second of F and G and the third of class M. Moreover, the two short-period groups exhibit a most remarkable property in that none of them, out of more than two hundred available examples, possesses a close companion, whereas about one star in five of normal stars of similar spectral classes does possess a close companion. On the other hand, long-period variables appear to possess a normal complement of companions. The first and third types are stars of moderate luminosity and show no pronounced galactic concentration, whereas the variables of intermediate period, the Cepheids, are strongly concentrated to the galactic plane and are among the most luminous known stars. Thus it is clear that very remarkable dynamical properties are intimately connected with even the different types of variability, and therefore that purely internal considerations are most unlikely to prove capable of elucidating the nature of the connexion.

From these and many other dynamical qualities associated with various types of stars, it appears to us that Prof. Gamow has over-estimated the importance of nuclear theory in the problem of stellar evolution. Indeed, in our opinion nuclear physics has very little to add to the results already conjectured by astrophysicists, and can merely serve to confirm these conjectures, a typical instance being the mass-luminosity relation itself. Finally, we wish to point out that although the present article consists largely of criticism, we have discussed elsewhere a number of the questions raised[2], and it has been found that purely dynamical considerations may be sufficient to provide a natural explanation of many of the difficulties mentioned in this article.

[1] NATURE, **144**, 575, 620 (Sept. 30 and Oct. 7, 1939).
[2] *Proc. Camb. Phil. Soc.*, (4), 35 (1939).
[3] *Mon. Not. Roy. Astr. Soc.*, **98**, 646 (1938).

SCIENTIFIC AND INDUSTRIAL RESEARCH IN CANADA

THE twenty-first annual report of the National Research Council of Canada includes the report of the president, with reports of the various divisions and of co-operative investigations, together with the financial statement and appendixes listing the publications of the Council and papers published by members of the staff and holders of research grants during the year.

Under the Division of Biology and Agriculture a good deal of attention has been devoted to plant hormones, and a simple method of treating seeds with plant hormone chemicals has been developed in which a carrier is utilized, either an inert dust such as talc or a seed disinfectant such as an organic mercurial or copper carbonate. It has also been found that a very small amount of hormone when added to the treated solution greatly reduces or entirely prevents the injury of seed in treatment with formaldehyde for control of smut disease. A joint project with the Dominion Forest Service and the Department of Agriculture dealing with forest tree breeding is to some extent an outgrowth of these plant hormone investigations, since the discovery of a method of inducing wood cuttings to root more freely has opened up new possibilities in this direction, particularly in the propagation of rapid-growing and disease-resistant trees. Further work on plant hormones has been carried out under an associate committee on this subject, and the Division of Chemistry has given a good deal of attention to the synthesis of a series of homologues of α-naphthylacetic acid, as well as developing an improved method for the synthesis of α-naphthylacetic acid itself. Other work under the Division of Biology and Agriculture has been concerned with grain research, including the standardization of an experimental baking test for wheat, experimental malting equipment and methods for barley, food storage and transport, including the effect of freezing treatment and rate of freezing on the quality of frozen poultry, beef, pork and mutton and a survey of packing plants exporting Wiltshire bacon. The Division has also co-operated with the Dominions Department of Agriculture in the development of hybrids between wheat and the Agropyrons or wheat grasses with the object of obtaining large-seeded drought-resistant grasses for western Canada, and some work has been carried out on the effect of phytohormones on bacteria and yeast.

The Division of Chemistry has examined the factors involved in the preparation of rennet casein suitable for the manufacture of plastics, particularly buttons, and the highly efficient packings for fractionating columns and scrubbing towers designed in the laboratories are now being developed in forms specifically suited for larger scale operations. Active contact has been maintained with the laundry and cleaning industries of Canada, and the Division has also co-operated with the Sub-committee on Textile Specifications of the Canadian Government Purchasing Standards Committee. An investigation of the laundry cleaning process with sodium hypochlorite has been concluded, and work carried out on the efficiency of wetting compounds and mixtures for use in the first or 'break' operation where thorough wetting of the fabrics is of importance. The magnesian products laboratory of the Division has made available to the Canadian metal industry better refractories and a wider range which can be obtained from Canadian materials, notably the product of high-grade refractories from dolomite.

Various barks have been investigated as a source of tannin for the leather industry, and in the rubber laboratory much work has been done on bonding rubber to leather, particularly the application to the manufacture of automobile engine mountings of a bonding material previously developed in the laboratory. Numerous tests have been made of such materials as paints and textiles on behalf of the Canadian Government Purchasing Standards Committee, while a process for the preparation of organic mercury derivatives, particularly alkyl mercuric halides and other salts used for seed disinfection, has been developed. Use of the disinfectants in the form of a dust consisting of an inert carrier adapted to adhere to the seed has also been studied, and Canadian bentonites or talc proved satisfactory as carriers, the dust being equal in disinfecting power to the best imported products. Work on synthetic resins has been extended to cover the formation of polymers from chloromethyl compounds.

The Division of Chemical Engineering has a wind tunnel for testing aeroplane models and streamlined locomotives and other equipment in which air resistance is important, and a model-testing basin in which similar problems in regard to water can be investigated. Safety tests are continually made of domestic oil, gas- and gasoline-burning appliances. Five ship models were tested during the year in the towing basin in connexion with the design of private and Government vessels. Numerous aircraft instruments, gasoline and lubricating oils have been tested for various branches of the Government service.

In the Division of Physics and Electrical Engineering an increasing amount of standardization and testing work of all types has been carried out. In addition to studies of the heat insulation properties of building materials, the development of a suitable thermostat for refrigerator cars has received much attention. Thousands of aircraft castings have been examined by X-ray methods; and the cathode ray compass and direction finder, detection of fire through haze, estimation of forest fire hazards, vibration in aircraft and ultrasonic generators for depth sounding are other problems under investigation.

Steps were taken during the year to reorganize the Division of Research Information and establish a Section of Research Plans and Publications, one function of which is to provide technical secretarial services for the president and some of the associate committees. Stress is laid in the report on the organization of an Associate Committee on Medical Research. The Associate Committee on Grain Research has outstanding achievements to its credit in the solution of problems relating to bread wheat. Studies of the drying of tough and damp wheat have established the conditions under which this can be done without injury to the milling and baking quality of the grain. Other investigations dealt with seed injury by fungicidal treatments, effect of formaldehyde treatment on the growth of wheat and prevention of heating of damp grain in storage.

R. H. THURSTON: ENGINEER

CENTENARY CELEBRATIONS

THE celebration of the centenary of the birth of the distinguished American engineer, Robert H. Thurston, held at Cornell University on October 25, was the occasion for the delivery of several addresses in which tribute was paid to the great influence Thurston had on engineering education and progress, and also reference was made to the part the engineer should take in the solving of social and economic problems. The addresses were given in the Bailey Hall before an audience of more than a thousand persons, which included many of Thurston's old students and delegates from no fewer than sixty universities and institutions in the United States, Great Britain, Canada, France and Germany.

When inaugurating the proceedings, Dr. E. E. Day, president of the University, said that in the tense and hurried living of this twentieth century of ours, it is difficult and at times well-nigh impossible to keep in clear view the importance of the really durable values of life. No corrective for this difficulty is so sure as the occasional review of the qualities of leadership in great men. War-racked and depression-ridden though this world may be, the force of individual character remains undiminished. As the years of Thurston's active service recede, his contributions to the upbuilding of Cornell lose none of their impressiveness, while the lives of the men who went out from his tutelage continue to attest the strength of his mind and spirit.

After speeches in which Thurston's training at Brown University, and his work as a naval engineer and as an instructor at the United States Naval Academy had been recalled, Dr. H. N. Davis, president of the Stevens Institute of Technology, Hoboken, dealt with "Pioneering in Engineering Education at Stevens". Thurston had joined President Henry Morton at Stevens in 1870, when thirty-one years of age, and he brought to bear upon the problem of an engineering curriculum an original mind, a wide outlook and great force of character. There were two aspects of his work at Stevens, said Dr. Davis, that seemed likely to be permanent parts of the Thurston

tradition in engineering education. First he seems to have invented the idea that a mechanical laboratory is an appropriate part of an American Engineering School. It is, of course, difficult in 1939 to realize that in 1870 this idea had to be invented.

Thurston's conception of such a laboratory was a threefold one; first, it should be a place where a student could become practically acquainted with working machinery; secondly, it should be a place where staff and students, working together, might by research make important contributions to the progress of engineering; and thirdly, it should be a place to which industry could bring its problems, whether of testing, of design and development, or of a still more fundamental nature.

For his laboratory Thurston invented testing machines, and as a servant of industry the laboratory played an important part when few, if any, industries had their own plant for routine testing. From "a schedule of charges" dated 1877, and signed by Thurston, it appears that a test on the "autographic recording testing machine, of strength, ductility, resilience, and determination of elastic limit, elasticity, homogeneousness of structure and amount of internal strain, with strain-diagram and record" could be had for three dollars. A trial of a steam engine or boiler could be made for twenty-five dollars plus sixty cents an hour for field and office labour.

Thurston also had a conception of the fundamental position in mechanical engineering of the two great fields of the study of the properties of materials and of the problems of power. Further, he foresaw the position engineers were likely to occupy as industrial executives, and himself set an example to others by taking part in public affairs. He exemplified, concluded Dr. Davis, "a conception of the scope of the service of the engineer that may well be our inspiration and ideal for many years to come".

The fourth address was by Dr. W. F. Durand, his biographer, who dealt with Thurston's eighteen years, 1885–1903, at Cornell, and the concluding address was by Prof. S. C. Hollister, dean of the College of Engineering, Cornell, and was entitled "Looking to the Future". After referring to the great material developments since 1868, when engineering was first taught at Cornell, Prof. Hollister asked, "What has all this development done to human living?" New problems have arisen of vast social import, and to every phase of the scene, as he saw it, the engineer has a direct relation. He must be prepared to cope successfully with changes wrought by scientific and technical advance; he is concerned with production, processes and organizations; he is involved in problems of management, finance, public relations and government. It seems clear that he is bound to be involved more and more in the social and economic problems that lie ahead.

There is but one way of preparing young men for our expanding technical future, namely, to train them broadly and deeply in the fundamental sciences. Some feel that engineers are not trained in civic consciousness and usefulness. Prof. Hollister thinks it only fair to say that the whole educational field awaits with interest convincing testimony that any given curriculum accomplishes this very desirable end. Civic consciousness is a matter of community attitude rather than the result of studying any system of subjects. The surest way to provide the right community attitude is to prepare men and women thoroughly for the parts which they are to play in the community. Cornell for many years has, in varying degrees, been functioning in this direction.

MANUFACTURE OF RADIO SETS FOR EXPORT

ACCORDING to the *Electrical Times* of November 16, British manufacturers are often criticized for not studying the requirements of overseas markets. The reason for much of this criticism is easy to understand, as the conditions in the home markets of several of our international competitors are very similar to those in overseas countries which are large purchasers. To take a case in point, consider the export of radio sets.

It is common knowledge that, in the early days of foreign competition in the radio market, foreign competitors took the lead. In the United States, for example, where a widespread short-wave broadcasting system was employed, manufacturers found that little modification to the standard models was required to make them suitable for reception to distant parts of the world. British manufacturers had no similar home experience to rely on. Several of the leading firms in Great Britain have now built up an export market for models which have been specially designed for overseas use and have achieved success in winning back lost ground. The General Electric Co., Ltd., has an organization of a world-wide network of completely equipped and technically staffed branches which offer great facilities for before and after sales service. Its experts travel the world studying reception conditions and problems at first-hand. In one tour alone Nigeria and Siam, Canada, India, New Zealand and Hawaii were visited, the total distance traversed being 50,000 miles. As a result of the valuable information obtained great improvements in design were facilitated and many special tests, which every G.E.C. overseas radio receiver now undergoes as a matter of routine, were devised.

Illustrations are given in the *Electrical Times* of the apparatus used in the special laboratory and factory tests on the sets in the 'humidity cabinet'. In this cabinet any required temperature and relative humidity can be obtained and also the cyclic variations representative of tropical climates. Synthetic resin insulation, used for wave change switches, and rubber insulation receive special treatment in respect of both electrical and mechanical properties. In the artificial ageing test, specimens are subjected to high temperatures in an oxygen atmosphere and must remain unimpaired after 200 hours' treatment. One of the tests for the mechanism of switches is to perform satisfactorily 50,000 operations. A motor-driven reciprocating mechanism operates the switch during the test. An instrument is also used to check the moisture content of wooden components to ensure that seasoning has been thorough. During the manufacture of mica condensers all the operations are carried out in a filtered air-conditioned room and glass screens protect the condensers from the operator's breath.

FACTORIES AND THE BLACK-OUT

THE many problems which have been encountered by those responsible for blacking-out factories in the present emergency were discussed in some detail at a meeting of the Chemical Engineering Group of the Society of Chemical Industry which was held in the rooms of the Chemical Society, Burlington House, London, on December 8. Mr. H. W. Cremer presided and opened the discussion, during which it was manifested that the actual blacking-out in itself did not produce the only difficulty. It has been found that there are psychological and physiological effects on the workers, to say nothing of difficulties which have been introduced in the matter of ventilation. As regards the latter, the need for blacking-out factories has rather revealed that there is yet a great deal to be learned concerning the ventilation of factories in normal times, and the suggestion that this problem should be gone into more thoroughly is likely to be taken up by the Committee of the Group.

Mr. Cremer directed special attention to the problem of ventilation and its effect upon night workers, plus the effect of reduced lighting, stressing that factories should be designed normally—and reorganized in present circumstances—with an appreciation of the fact that they have to house human beings as well as machines.

Mr. L. W. Robson, of Messrs. Nobel's Chemical Finishes, Ltd., speaking of the actual physical problems of blacking-out, strongly advocated the extensive use of paint, which he said can be applied rapidly, is cheap and permits of uniform lighting conditions being obtained in the factory by day and by night, so that the efficiency of workers is not affected by changes in degree of illumination prior to and after black-out times. He admitted that the objection to this is a considerable increase in the lighting bill, but claimed that the objection is not so great as is sometimes made out. For example, in the case of buildings camouflaged with paint or netting, the daylight illumination is often reduced to an extent which necessitates artificial lighting during the daytime. Again, in many engineering shops where fine work is done, bench lights are in constant use, irrespective of daylight or darkness.

Remarking that oil-bound distempers, oil paints and bituminous paints are all suitable for blacking-out purposes, Mr. Robson spoke also of the use of aluminium paint for vertical windows, which improves the general brightness of a room by its reflection, but it must not be used on roof lights, as it increases glint.

An alternative to the complete obliteration of windows is the use of complementary lighting, the colours chosen being usually orange and blue. This system is based on well-known optical principles and entails the conversion of the windows to blue filters which will not pass orange light, and the use of lamps which give orange light free from any blue rays. The lamps may be sodium vapour lamps or gas-filled lamps made of suitably coloured glass, or ordinary lamps suitably lacquered. It was emphasized that photographic workers find no difficulty in working in red or green light of much lower intensity than is afforded by this scheme. (Incidentally, there was some difference of opinion among the speakers on this matter, some referring to trouble with their workers owing to this form of lighting and others saying there had been none, after a short period of time.)

Mention was also made of fluorescent and phosphorescent paints. Fluorescent paints or pigments, of course, give off visible light when excited by invisible ultra-violet light but have no after-glow when the excitation is removed, whereas phosphorescent paints continue to glow after the exciting source is removed. The pigments used in these paints are based on zinc and cadmium sulphides. They must be incorporated in a special medium, and the paint, when applied, should be protected with a final coat of clear medium. These paints are obtainable in a variety of colours and glow brilliantly when used with a 'black' lamp.

There are, of course, numerous applications for such paints under black-out conditions, and it is recommended that where a paint is required for direction indicators in a building which will be suddenly blacked out when a warning is received, it should be of the zinc sulphide type, because of initial brightness. On the other hand, outside signs, or doorways which must be found after many hours of darkness, should be painted with an alkaline earth paint.

Dr. G. E. Foxwell said he had found that vertical retort tar, when heated under certain conditions with lime, had been found excellent for blacking out roof lights and was very resistant to moisture, showing no signs of peeling off. Mr. F. A. Greene remarked that he had discovered this many years ago, and added that with good quality tar there was no need for treatment with lime.

A number of other points were raised during the course of the discussion, in which some twenty speakers took part, and many of them concerned the extreme difficulty of complying with the regulations and maintaining manufacturing efficiency. For example, there are the numerous cases of large furnaces and the problem of blacking out the glow from them. In one case, where a complete black-out was effected, the men could not continue their work for more than two hours at a time. Some relief was obtained with a system of louvred ventilation combined with a degree of light restriction, but it was extremely costly.

One speaker remarked that where a complete black-out had been 100 per cent effective, it was practically 100 per cent defective as regards the workers, who objected to the orange lights and blue windows. The lighting of goods sidings at night has also entailed much difficulty and restriction of operations, but permission has been given by the authorities for a modified form of lighting and an arrangement of switches by which all lights can be instantly extinguished should a warning be received.

Another difficulty referred to was that of the increase of temperature in buildings under black-out conditions, due to reduced ventilation in consequence of windows having to be kept closed to prevent emission of light.

SCIENCE NEWS A CENTURY AGO

The Birmingham Mechanics' Institution

ON December 17, 1839, an exhibition was held at the Mechanics' Institution in Birmingham and a correspondent wrote to the *Athenæum*, "It contains more than one hundred thousand articles arranged very tastefully in the rooms belonging to the Institution. Ornithology is the richest department in Natural History: there is a very perfect collection of British birds belonging to Dr. Lloyd; and a beautiful collection of the varieties of humming bird, prepared by Mr. Heywood, a mechanic of Coventry, who devotes his leisure hours to the cultivation of Natural History. . . . The departments of Geology, Mineralogy, and Crystallography are rich, but not extensive. . . . The models of engines, machinery, etc., are not so numerous as they were in the Grammar School during the visit of the British Association, but among them are some articles which were not then displayed, especially some lathes of admirable construction and great power."

Fossils from the London Clay

ON December 18, 1839, Richard Owen read to the Geological Society a paper "On the Fossil Remains of a Mammal, a Bird and a Serpent, from the London Clay". Until a few months previously the highest organized animal remains known to exist in the London clay were those of reptiles and fishes. In collections at Ipswich and Woodbridge, however, had been discovered teeth of a quadrumanous animal, of Cheiroptera, plantigrade and digitigrade carnivora, and of a species probably belonging to the marsupial order. These had been found in the London clay of Suffolk. To these Mr. Owen had been enabled to add remains of a new and extinct genus of pachydermatous mammals, of a bird and a serpent. The first of these had been discovered in the cliffs of Studd Hill, near Herne Bay, by Mr. W. Richardson and consisted of a small mutilated cranium, about the size of that of a hare, containing the molar teeth of the upper jaw nearly perfect, and the sockets of the canine. The remains of birds consisted of a sternum with other bones, and a sacrum, both found at Sheppey. The sternum forms part of the collection of fossils formed by John Hunter. One of the specimens of extinct species of serpent was likewise in the Hunterian collection and consisted of about thirty vertebræ. This also was found at Sheppey.

Light from Plants

AT a meeting of the Botanical Society on December 20, 1839, reported in the *Athenæum* of December 28, Dr. Willshire communicated all that was then known with respect to the evolution of light from plants, a subject which had recently attracted some attention on the Continent, but which was first observed in *Tropaleium majus*. The subject was divided into two portions, namely, light evolved from dead and living vegetable structures, and it appeared that wood rotted in the air never shines, it being requisite to be buried in the earth, when the sap is contained within it. It was observed that this effect takes place only in the months of July and August, in warm dry weather, never in damp. Several plants were mentioned as evolving light during the putrefactive stage, among others, mushrooms, potatoes, etc.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

TEACHER OF ENGINEERING SUBJECTS—The Principal, Luton Technical College, Park Square, Luton (December 20).

TEMPORARY DISTRICT OFFICER to the Essex War Agricultural Executive Committee—Executive Officer, East Anglian Institute of Agriculture, Chelmsford (December 22).

TWO UNIVERSITY GRADUATES (male and female) to teach English in a Lycée in Ankara—The British Council, 3 Hanover Street, W.1 (envelopes marked 'Turkey') (December 27).

CIVIL ENGINEERING ASSISTANTS in connexion with the Haweswater Scheme—The Secretary, Waterworks Offices, Town Hall, Manchester 2 (December 28).

CHIEF EDUCATION OFFICER to the County Borough of Doncaster—The Town Clerk, 1 Priory Place, Doncaster (December 31).

SUB-LIBRARIAN at the University of Cape Town—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (December 31).

SCHOOLMASTER OFFICERS in the Royal Navy—The Director, Education Department, Admiralty, S.W.1 (January 2).

TEMPORARY MASTERS to teach Mathematics, Physics and Applied Physics—The Headmaster, Oundle School, Oundle.

RESIDENT ENGINEER to the Witham and Steeping Rivers Catchment Board—The Engineer to the Board, 50 Wide Bargate, Boston, Lincs.

LECTURER IN MECHANICAL ENGINEERING in the Witwatersrand Technical College, Johannesburg—Messrs. Frank Ross and Co., 9 Fenchurch Avenue, E.C.3.

UNESTABLISHED EXAMINERS in the W/T, Instrument, and General Engineering Branches of the Aeronautical Inspection Directorate of the Air Ministry—Inspector in Charge, A.I.D. Training School, Brandon Street, Bristol 1.

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

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